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Horizontal Boring and Milling Machine.

The lower engraving on this page is of a horizontal boring and milling machine which possesses the capacity and variety of movements necessary to adapt it to a very wide range of heavy work.

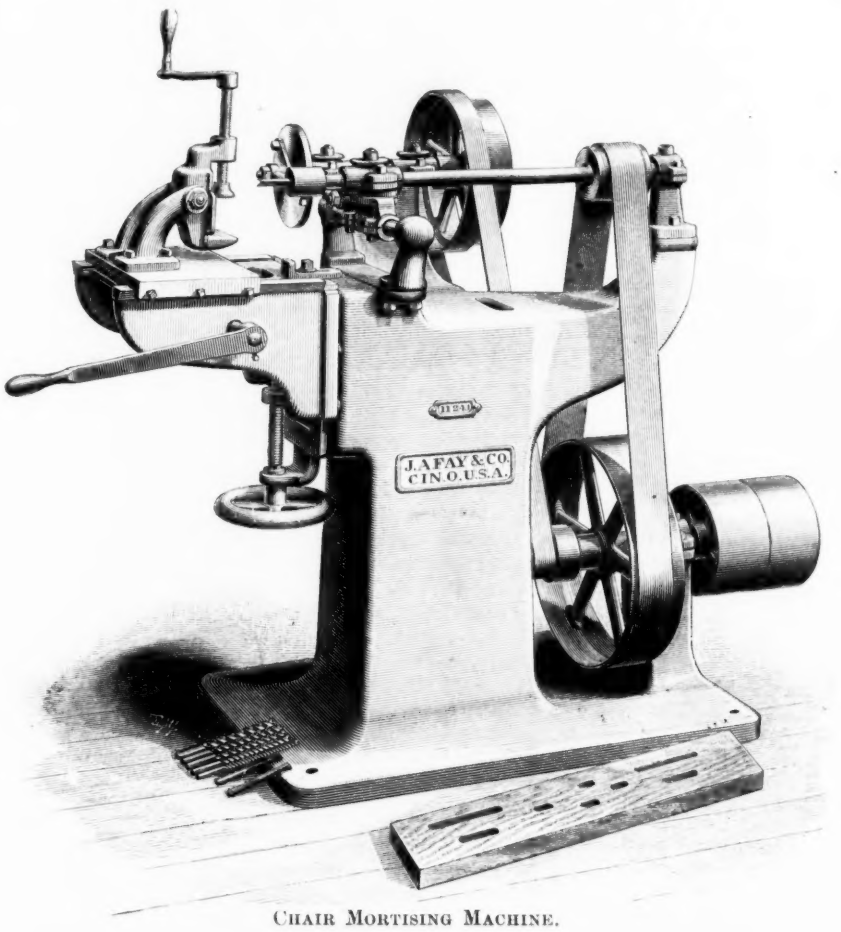
The machine consists essentially of a heavy bed, to which the post carrying the boring bar is permanently fixed, and the one carrying the outer support for the bar is movable along the bed to which it is gibbed in three places. The platen rests upon a saddle between the two posts, as shown, and can be given any desired movement either to bring the work into position for boring or for feeding when milling.

The saddle which carries the boring bar is counterbalanced, is gibbed to the face of the fixed post, and is raised or lowered upon it by the screw seen within the post, this screw being driven from a shaft which passes through the bed to the movable post, and by means of bevel gears drives also the vertical screw which moves the outer bearing, thus keeping them in line with each other.

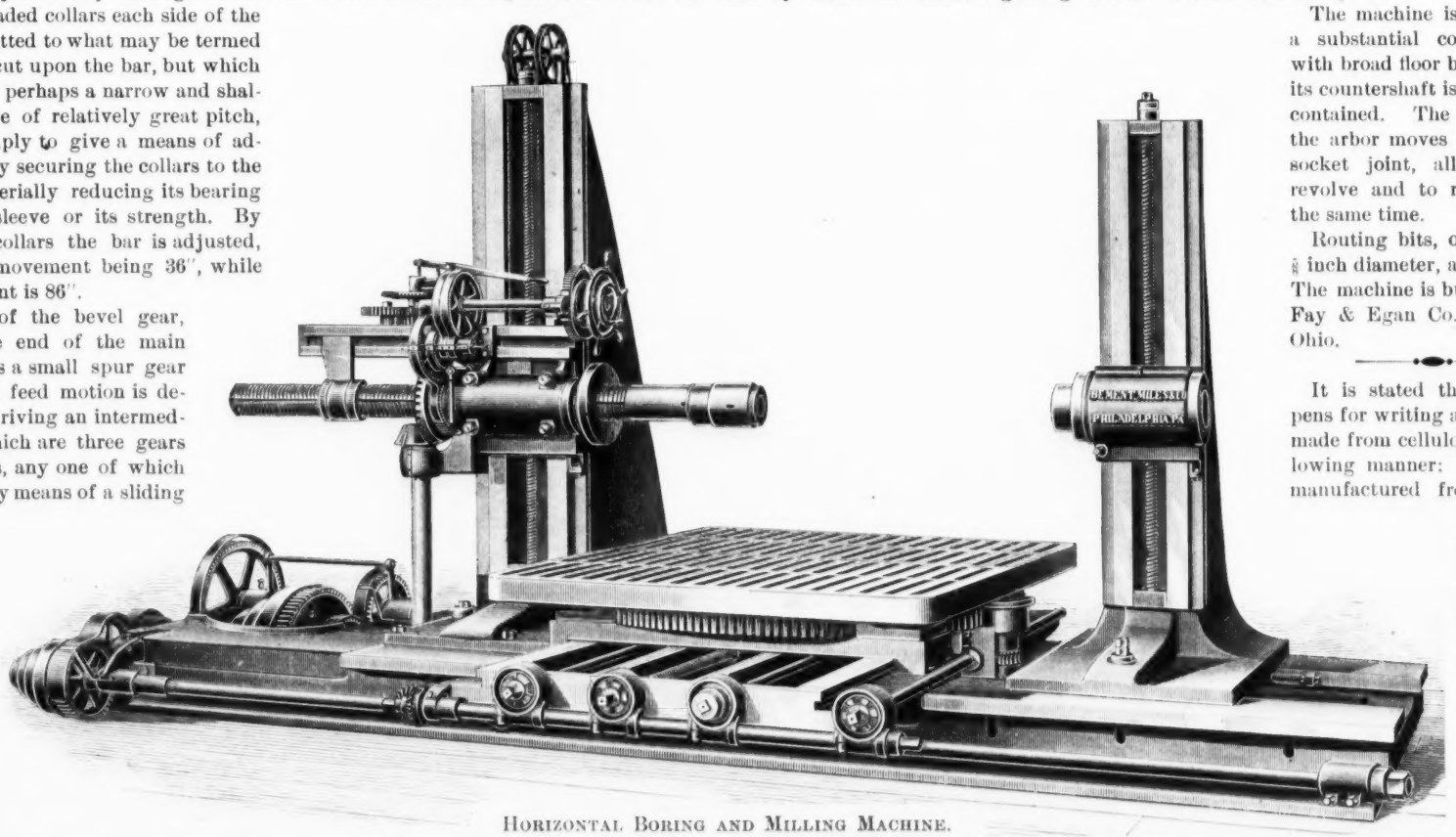
Rotary motion is transmitted to the boring bar by the vertical shaft seen at the left of the post, this shaft being splined to pass down below the floor when the head is low on the post. This shaft is in turn driven by means of bevel gearing from a horizontal shaft to which the driving cone pulley, with its back gears, is attached. Twelve different speeds are provided for.

Above the boring bar is a sliding bar of rectangular section, having a rack upon it, and to this sliding bar the feed motion is applied, an arm projecting downwardly from the feed bar and embracing the boring bar, which can pass freely through it except for the threaded collars each side of the arm, which are fitted to what may be termed a square thread cut upon the bar, but which is more properly perhaps a narrow and shallow spiral groove of relatively great pitch, which serves simply to give a means of adjusting and easily securing the collars to the bar without materially reducing its bearing surface in the sleeve or its strength. By means of these collars the bar is adjusted, its continuous movement being 36″, while its total movement is 86″.

At the back of the bevel gear, which is at the end of the main bearing sleeve, is a small spur gear from which the feed motion is derived, this gear driving an intermediate shaft on which are three gears of different sizes, any one of which may be driven by means of a sliding key. These engage with three gears keyed to the shaft above, which in turn drives another shaft behind it carrying at one end the hand wheel for moving the bar and the friction clutch, while at the other it drives by means of a bevel pinion and gear a vertical shaft on which are two spur gears either of which can be driven by a sliding key which is controlled by the lever seen above. These gears drive the shaft on which is the rack pinion, and thus six rates of feed are provided for. The shaft from which the various motions of the platen are derived runs along the front of the bed. This is driven either by the cone pulley for feeding motion or by the spur gears shown for the traversing motions, and by means of suitable gearing drives the shorter shaft which passes along the front of the saddle. From this shaft, by means of the worms and wheels with their clutches as indicated, the various motions to the platen, along the bed, transversely and rotary are derived, the latter being by means of the worm-driven pinion at the right of the platen which engages with the large spur gear, portions of which are visible.



CHAIR MORTISING MACHINE.



HORIZONTAL BORING AND MILLING MACHINE.

The bed of this machine is made of any desired length. The vertical movement of the head upon the post is 66″; transverse movement of the platen upon the saddle 95½″. It is built by Bement, Miles & Co., Philadelphia, Pa.

Chair Mortising Machine.

The first illustration on this page is of a machine designed especially for making mortises in parts of chairs and for similar work. The principle of its operation is that of the routing machine or of the machinists' key seat drill, there being a rotary cutter which is made to move back and forth laterally while cutting, thus producing the mortise.

The reciprocation of the boring and mortising arbor is effected by means of a connecting rod and an adjustable crank-pin attached to the face-plate of the driving shaft, having variable speeds. Any length of mortise equal to the travel of the cutting bit, which is 4 inches, can be made by changing the position of the crank-pin. The depth of the mortise or the hole to be bored is gauged by the stop on the table. The table that supports the material is fed forward to the stop by means of a hand lever with rack and pinion connection.

The table is raised vertically by the screw and hand lever, and is provided with three clamps of different forms for holding the material in the position required for the work to be done upon it.

The machine is mounted on a substantial cored column, with broad floor base, and with its countershaft is entirely self-contained. The fixed end of the arbor moves in a ball and socket joint, allowing it to revolve and to reciprocate at the same time.

Routing bits, one each ⅝, ½, ⅜ inch diameter, are furnished. The machine is built by J. A. Fay & Egan Co., Cincinnati, Ohio.

It is stated that in France pens for writing are now being made from celluloid in the following manner: Thin sheets manufactured from celluloid, ebonite, vulcanite, etc., corresponding with the outlines of a pen are stamped out, punched, and finally laid in a softened condition in a press that has been heated, by which means they receive the desired shape. After being cooled in a water-bath the pens thus obtained are split with a knife.

Early Engineering Reminiscences.

By GEORGE ESCOL SELLERS.

THE UNITED STATES MINT—I.

For some years an older brother and myself had much to do with the machinery for the United States Mint. This was during the period of the transition from hand coinage to coining by steam power. I have been asked to note some of my recollections in that connection, as such reminiscences, I was told, might be of historic value, as well as of interest to the progressive mechanics of the present time. To comply with this suggestion, I have to depend mainly on memory, which at my age is not entirely to be relied upon; so far as dates and names are concerned, memory may be sadly deficient. Fortunately, however, I have kept among an accumulation of old drawings and sketches some working drawings and others merely suggestive sketches of detached portions of the mint machinery, in many instances barely sufficient to enable me to reconstruct the old machine in a sort of mental picture. These drawings, not always dated or indorsed in any way, have recalled much that otherwise would have been forgotten. If I derive anything from them worth recording, it can only be in a rambling desultory manner.

I am not deficient in the kind of memory that retains object lessons of form, location and surrounding; a mental quality that should be cultivated by both civil and mechanical engineers. I now frequently recollect some striking object lessons in mechanics and engineering designs of more than half a century ago as vividly as if only of yesterday's occurrence. To illustrate what I mean, and to make the illustration impressive, I will give an instance of the importance of cultivating this kind of mental picture of scenes or objects. When about fifteen years of age my "fad" was comparative anatomy. I attended two winter courses of lectures and spent much time in the dissecting room and became quite expert in making anatomical preparations, which is a truly mechanical part of the science. As years went by almost all the nomenclature of the human anatomy was forgotten, but the mental picture of the component parts of the human frame as seen by me remained, to be of after use in several cases of severe accidents, where under compulsion this early knowledge was utilized. Thus, in one case a man had his foot caught in a railway frog whereby it was crushed almost to a pulp, and the poor fellow would have bled to death but for the immediate application of a knotted handkerchief applied with a stick twister. as my recollection of the anatomical structure suggested it should be. Amputation, however, was necessary. From the location of the railroad from the coal mines where the accident occurred, it was impossible to carry the man to any experienced surgeon. A country physician was called in, who nervously undertook the case, but he, unused to such work, soon sickened and grew faint and very gladly accepted my assistance, which from my early recollections I was able to give, in taking up arteries, and together we accomplished what might have been too much for the doctor alone.

This has nothing to do apparently with the subject proposed from my papers, but I give it nevertheless as a striking example of the necessity of training both the mind and hand to do any work that they may be called upon to do, and to the engineer all human knowledge may sooner or later come of use.

Naturally, as the capital of the United States at the time, the first mint was located in the city of Philadelphia, and few realize now the humble beginning from which the greater mints of the country have sprung. The old U. S. Mint in Philadelphia was on the east side of Seventh street, on one of those areas called in Philadelphia a city block, these blocks being bounded on their four sides by the principal streets, and perhaps subdivided into smaller blocks by alleys or courts. The particular block in question was between Sixth and Seventh streets on the east and west and Market and Arch on the south and north, and in point of fact the building was about midway of the block on the corner of a small street named Sugar Alley, which ran from Sixth to Seventh streets, bisecting the block. The building used for the mint had very much the appearance of an ordinary three-story brick dwelling house of that period, the back building and yard extending on the alley. In a rear room, facing on the alley, with a large, low down window opening into it, a fly press stood, that is a screw-coining press mostly used for striking the old copper cents. Through this window the passersby in going up and down the alley could readily see the bare-armed vigorous men swinging the heavy end-weighted balanced lever that drove the screw with sufficient force so that by the momentum of the weighted ends this quick-threaded screw had the power to impress the blank and thus coin each piece. They could see the rebound or recoil of these end weights as they struck a heavy wooden spring beam, driving the lever back to the man that worked it; they could hear the clanking of the chain that checked it at the right point to prevent its striking the man, all framing a picture very likely to leave a lasting impression, and there are no doubt still living many in Philadelphia who can recollect from this brief notice the first mint.

The impression made upon me as a boy was the more enduring as it was one of almost daily occurrence. The block on which the old mint stood, besides being divided by Sugar Alley, had on Sixth street near Market the entrance to what was known as Mulberry Court. This court extended nearly half way to Seventh street, and at the head of the court was a dwelling house facing the entrance to the court. This house separated Mulberry Court from another alley or court that entered from Seventh street, known as St. James street. The difference between the terms alley and court in this case was that the name alley was given to a narrow street of uniform width, either entirely passing through the block or entering it for a short distance, while the term court was applied more particularly to a narrow entrance from the main street widening into a broader area, around which area the more pretentious houses were frequently erected. On the north side of Mulberry Court were three dwelling houses, in one of which I first saw the light. The lot where stood the house in which I was born cornered with one on Sixth street occupied by Mr. Frederick Graff, who followed Latrobe as engineer of the Philadelphia water-works, and who designed and constructed the Fairmount water works; a gateway connected our yards. Mr. Graff was one of my father's most intimate acquaintances, who with Dr. Robert Patterson, then in charge of the mint, and Adam Eckfeldt, chief coiner, were together frequent visitors at our house on the court; it was a clannish neighborhood, gates connecting all our yards, even to the yard of the fire-engine shops carried on by Jacob Perkins and my father at the end of St. James. From this yard was an opening into Sugar Alley, which to us as youngsters had other attractions than the coining press, for there stood the little shop of the best molasses candy maker in Philadelphia. The house at the end of the court was eventually removed, the street being then called St. James street, now Commerce street, of which street it is a continuation.

One day in charge of my elder brother I stood on tip-toe with my nose resting on the iron bar placed across the open window of the coining room to keep out intruders, watching the men swing the levers of the fly press; it must have been about noon, for Mr. Eckfeldt came into the room, watch in hand, and gave a signal to the men who stopped work. Seeing me peering over the bar, he took me by the arms and lifted me over it. Setting me down by the coining press asked me if I did not want to make a cent, at the same time stopping the men who had put on their jackets to leave the room. He put a blank planchet into my hand, showed me how to drop it in, and where to place my hand to catch it as it came out; the lever and weights were swung, and I caught the penny as we boys called cents, but I at once dropped it. Mr. Eckfeldt laughed and asked me why I dropped it? Because it was hot and I feared it would burn me; he picked it up and handed it to me, then certainly not hot enough to burn; he asked if it was not cold when he gave it to me to drop into the press; he told me to look and see there was no fire. and feel the press that it was cold; he then told me I must keep the cent until I learned what made it hot; then I might, if I liked, spend it for candy.

When I showed the bright new cent to my father, whom I found in his workshop, and asked him to tell me what made it hot, he said he would show me; he handed me a common sulphur-tipped match, then took up a small rod of copper, told me to feel that it was cold, held its end on an anvil, and struck it a few quick sharp blows with a hammer, then applied it to the match which I held in my hand, which to my amazement was at once ignited; he said, now you have something to think about and may be able to understand when you are older; it was an object lesson that led to many a train of thought. When years after in speaking of it to my mother's father, Charles W. Peale, he took up an old file of letters and sorted out a number from Benjamin Thompson (Count Rumford) and read from them many passages descriptive of his wonderful experiments and researches into the nature of heat, and its generation by friction or percussion, that have since been so beautifully illustrated and enlarged on by Prof. John Tyndall in his work on "Heat as a Mode of Motion," and by Joule on the "Corelation of Forces," after a lapse of over half a century.

In this rambling dissertation I have not yet done with my first coined penny that was to have been kept until I learned the cause of its sudden heat. It could not have been many days before I lost it in a manner as strongly impressed on my mind as was its coinage. I dropped it on a flight of rude heavy stone steps and saw it roll into a hole or crevice back of one of the steps, past all hopes of recovery. I was with my grandfather Peale and his wife, visiting a brother of Mrs. Samuel Moore, who we were taught to call Uncle Samuel. It was at his flour mill on a creek that ran into the Schuylkill some distance above Philadelphia. The journey to the mill was made in a one-horse gig (shay) I sat on a stool with my back to the dashboard, with grandfather's foot against the dash on one side of me and grandmother's foot on the other, to guard against my falling out. The flour-mill on the creek, a stone building with men making flour barrels, the great stone hillside dwelling house with flight of stone steps from the road to the cooper shop, were all as strongly pictured on my brain as it was possible to be on one so young. After many years something occurred that brought the lost penny to mind, and I asked my mother what recollections she had of my visit with my grandparents to Samuel Moore? She had none whatever; she did not think it possible that when so young I would have been allowed to go, even if they would commit such folly as to have taken me; she thought it was only a vivid dream; she was so positive that I began to think she might be right.

Years afterwards when carrying on our foundry and machine works we were applied to by Mr. Bethel Moore (an old customer for machine cards), the then owner of a woolen factory, for plans to help his water-power by steam engine at seasons of drought. As his factory was only three or four hours' drive from our works I decided to drive there to obtain dimensions and make the plans required. I did so, taking my wife and little son with me in a two-wheel stanhope, my son on a stool back against the dash, just as I had *dreamed* of having *ridden* with grandfather. Although the factory was so near home I was not familiar with the country in that direction. As we neared the place I got glimpses that recalled to mind the early ride; when we came to the stone hillside dwelling house, two stories high on the road by which we approached and three stories on the mill road below, the stone steps from upper to lower road, all so familiar, it must certainly be the place where I lost my precious penny; the name Moore of the present owner being the same seemed to confirm it. On speaking of it to him he said that some twenty or more years previous the place had belonged to a Mr. Samuel Moore, but no connection of his family.

The woolen factory had been added to the old flour-mill, which was still standing and had been converted into the fulling mill and was the water-wheel house of the factory in which the auxiliary steam engine would have to be placed. The stone building near the foot of the steps might have been, as I supposed, a cooper shop, but he had enlarged it for his dye house. As we entered it I pointed to a window opposite the door and back of the dye kettles, and said if the same window frame remains, Samuel Moore cut on the window sill what he said was my name. An accumulation of rubbish and dirt was cleaned off, the sill was rotten and portions gone, but G. E. S., 1812, which had been deeply cut, was still visible. Then being satisfied that the early picture was not a dream, I turned my attention to the flight of stone steps, walking several times up and down. The crevices and irregular holes had become filled with soil out of which was a luxurious growth of grass and weeds, the portions not foot-worn covered with moss and lichens. It was some time before I could locate the spot, but after pulling up several tufts of grass a hole was exposed that appeared like what I recollected of the hole into which the penny had rolled. To make the matter certain a crowbar was brought and the step lifted, and there lay the once bright cent, thickly coated with the green copper oxide; it bore the date 1812, evidence that I was only about four years of age when the picture of its coinage, its loss, and the other incidents were so indelibly impressed on the storehouse of my brain.

The little yard in the rear of the old mint was a very attractive place to us youngsters; its great piles of cord wood, which by the barrow load was wheeled into the furnace room and thrust full size in the boiler furnace, which to my young eyes appeared to be the hottest place on earth. There almost daily was to be seen great lattice-sided wagons of charcoal being unloaded, and the fuel stacked under a shed to be used in the melting and the annealing furnaces.

As I grew older and better able to understand, my interest in all the various processes increased, from the fuel yard to the melting room to see the pots or crucibles charged with the metals and their fluxes placed in the furnaces and the fires started, and when melted to see the man with his cage-jawed grasping tongues lift the crucible out of the fiery furnace and pour the melted metal into the ingot molds. Then the rolling these ingots into strips of sheet metal, splitting and turning them into narrow strips by revolving cutting shears. Thinning or pointing the end of the strips by rollers with flatted spaces on them, so that the strips can be inserted between the regulated and fixed dies of the draw-bench to equalize their thickness as they are seized by a pair of nippers or gripping tongues, the hooked handle of which the operator at once engages in a link of the constantly traveling chain by which the strip is drawn through between the dies, the operator then by hand pushed the grippers back into place to take a grip on another strip. These strips were fed by hand into the planchet cutting out presses, and it required practice to attain the adroitness to so handle the strips to cut them out to the best advantage so as to leave the least metal to be returned to the melting pots. Silver planchets by the rolling and drawing process become too hard for coining without first annealing. Then the hand-milling press was a very interesting one to watch, it was raising and notching or lettering the rim of the planchet as a preventive against clipping or robbing. This was done by rolling between grooved and notched parallel rulers or bars, one being fixed, the other movable endways by a pinion working into a rack. The oper-

ator after placing two planchets one in advance of the other between the parallel bars, then by a partial turn of a hand-crank the movable bar is thrust ahead sufficiently to entirely rotate the planchets, when they are taken out and two others put in. Every gold and silver planchet as cut out was passed through the hands of an adjuster; if overweight reduced by a file, a leather pouch in front of his bench catching the filings; if too light they were returned to the melter. I have no recollection of ever having seen the copper planchets for cents being made in the mint, but I have a vivid recollection of small iron hooped casks filled with copper planchets for cents and half cents. I have the impression that they were imported as copper in that condition and only stamped or coined in the mint. These casks were similar to the casks in which card wire was imported from England at that period. My object in giving these notes of operations of the old mint is that to the general reader the advances from the old hand to steam coinage and their importance and value may be understood.

Richards' Air Hoist.

We illustrate with this an air hoist, the invention of Frank Richards, whose address is P. O. Box 3686 New York City. The hoist here represented was made for a special purpose, in fact, these hoists are modified to suit different purposes, as required. Mr. Richards describes the hoist as follows:

Fig. 1 is from a photo of a hoist made for a special purpose and now in use. In this case the hoist was required to travel only six or eight feet along a straight beam. The hoisting hook is thrown up over the other ropes to get it into the picture, and the operating valve and connections are not shown. Everybody can see how the hoist works. The inner end of the cylinder is open. When air is admitted to the outer end of the cylinder the pressure acts upon the piston and the cylinder is thrust away carrying the sheaves mounted on its head and the hoisting is accomplished. The multiplication of the movement depends upon the number of sheaves. The hoist here shown is fourfold, and 18″ travel of cylinder gives 6 feet of lift. When the cylinder reaches the outer limit of its travel, and is stopped by the nuts on the end of the guide rods, the hook comes close up to the sheaves, and it will thus hoist higher than a chain hoist suspended in the same place. Where it is desirable to command the whole length of a straight beam the rope may be made with a hook at each end; then either hook may be fastened and hoisting may be done with the other one, one hook hoisting at one end of the hoist and the other hook hoisting at the other end of the hoist, as either may be wanted. Where longer travel is required the hoist may be suspended by hooks, Fig. 2, to regular trolleys, and may be run around curves or anywhere required. The air is supplied to the hoist either directly at the outer (and only) cylinder head or from the other end of the hoist through the piston rod, which in that case would be a pipe. The last arrangement is best where the hoist is used as a stationary hoist as in Fig. 3.

In connection with the hoist a valve of novel construction is provided. The air hoist requires a three-way valve, whereby the cylinder may be put in communication with the compressed air supply when hoisting, and with the atmosphere when lowering. The valve should move easily, and it should have considerable lap, so that when shut off slight or accidental movements will not open communication on either side. The opening should be at first fine and gradual, so that the hoist will not start too suddenly or go too far. The valve should be easily adjustable for wear. The common three-way cock is wanting in more than one of these particulars, and is not suitable for air hoists. All these points are well provided for in this special valve, and it is at the same time simple and cheap.

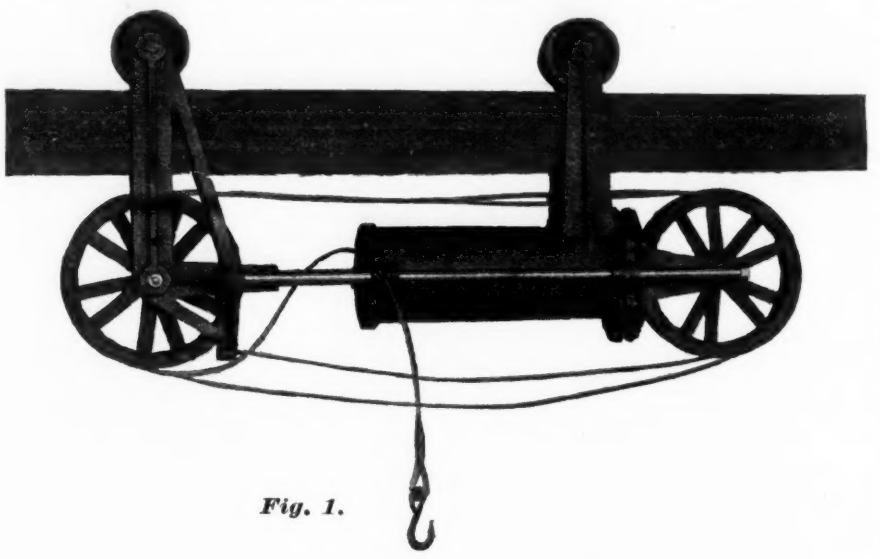


Fig. 1.

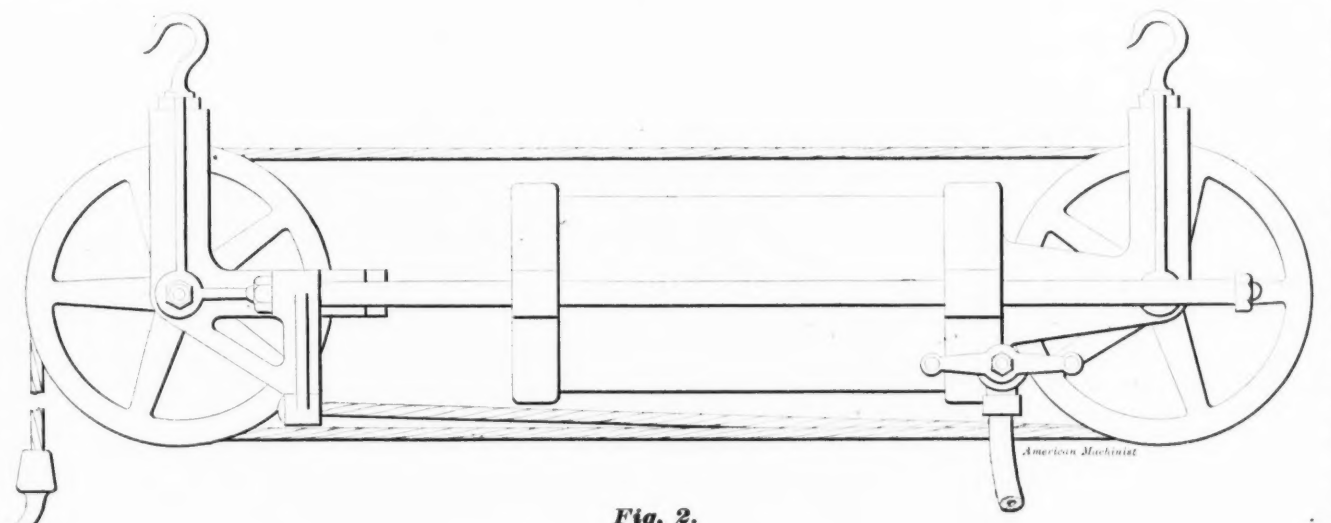


Fig. 2.

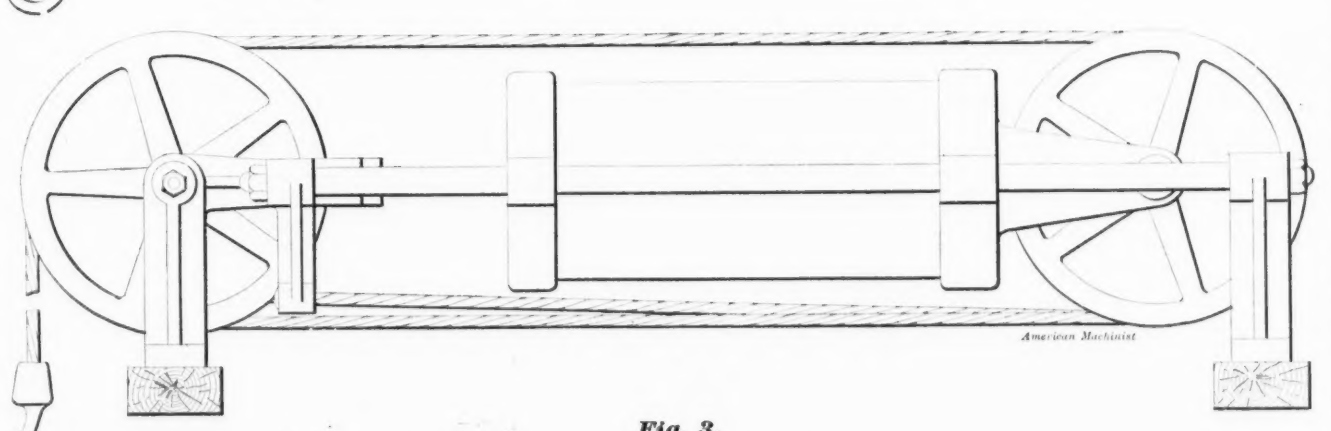


Fig. 3.

RICHARDS' AIR HOIST.

By the driving belt running off the pulley in a New York shop the engine "ran away," frightening 65 girls into running down stairs to the street, which so rattled the proprietor that he pulled the fire alarm, bringing the firemen around to stop the engine.

The Russian and Italian Governments now have torpedo boats that make 27¼ knots, with promise of others of greater speed.

Investigation of the Strength of Gear Teeth.*

BY WILFRED LEWIS.

To mechanical engineers, the strength of gear teeth is a question of constant recurrence, and although the problem to be solved is quite elementary in character, probably no other question could be raised upon which such a diversity of opinion exists, and in support of which such an array of rules and authorities might be quoted. In 1879, Mr. John H. Cooper, the author of a well-known work on "Belting," made an examination of the subject and found there were then in existence about forty-eight well-established rules for horse-power and working strength, sanctioned by some twenty-four authorities, and differing from each other in extreme cases about 500 per cent. Since then, a number of new rules have been added, but as no rules have been given which take account of the actual tooth forms in common use, and as no attempt has been made to include in any formula the working stress on the material so that the engineer may see at once upon what assumption a given result is based, I trust I may be pardoned for suggesting that a further investigation is necessary or desirable.

*Paper read before the Engineers' Club of Philadelphia.

In summing up his examination, Mr. Cooper selected the following formula from an English rule published at Newcastle-under-Lyme in 1868, and, as an expression of good general averages, it may be considered passably correct.

$$X = 2{,}000\ p\ f \qquad (1)$$

in which

X = breaking load of tooth in pounds.
p = pitch of teeth in inches.
f = face of teeth in inches.

In conclusion he makes this pertinent observation: "It must be admitted that the shape of the tooth has something to do with its strength, and yet no allowance appears to have been made by the rules tabulated above for such distribution of metal, the breaking strength being based upon the pitch or thickness of the teeth at the pitch line or circle, as if the thickness at the root of the tooth were the same in all cases as it is at the pitch line." Notwithstanding the fact that the necessity for considering the form of the tooth, as well as its pitch and face, was thus clearly set forth over thirteen years ago, I am not aware that any one else has taken the trouble to do it, and, as the results to be presented have been well tested by experience in the company with which I am connected, I believe they will be of interest and value to others.

In estimating the strength of teeth, the first question to be considered is the point or line at which the load may be applied to produce the greatest bending stress. In the rules referred to, the load is sometimes assumed to be applied at the pitch line, sometimes at the end of the tooth, and sometimes at one corner, but in good modern machinery, the agricultural type excepted, there is seldom any occasion to assume that the load is not fairly distributed across the teeth. Of course, it may be concentrated at one corner, as the result of careless alignment or defective design, in which the shafts are too light or improperly supported, and, for a rough class of work, allowance should certainly be made for this contingency, but in all cases where a reasonable amount of care is exercised in fitting, a full bearing across the teeth will soon be attained in service. It must be admitted, however, that on account of the inevitable yielding of shafts and bearings, even of the stiffest construction, the distribution of pressure may not be uniform under variable loads, and that the assumption of uniform pressure across the teeth is not always realized in the best practice. To what extent it is realized I shall not attempt to estimate, but in general practice, where the width of the teeth is not more than two or three times the pitch, the departure cannot be regarded as serious. The conclusion is therefore reached that in first-class machinery, for which the present investigation is intended, the load can be more properly taken as well distributed across the tooth than as concentrated at one corner. Having thus disposed of the first question, the second is, at what part of the face should the load be assumed to be carried in estimating the strength of a tooth?

Evidently the load may be carried at any point within the arc of action, and it might be argued that when a tooth is loaded

at its end, there are always two teeth in gear, and that the load should be divided between them. This is theoretically true of all teeth properly formed and spaced, but it must be admitted that mechanical perfection in forming and spacing has not yet been reached, and that the slightest deviation in either respect is sufficient to concentrate the whole load at the end of a single tooth. In time this concentration may be relieved by wear, but it is not so easily corrected as unequal distribution across the teeth, and, as the present practice of cutting gears with a limited number of equidistant cutters makes it almost impossible to obtain teeth of proper shape, it is evident that the load cannot safely be assumed as concentrated at a maximum distance less than the extreme end of the tooth. In some cases, of course, the teeth will not be so severely tested, and the error in this assumption compensates in a measure for the error in the first assumption of equal distribution across the teeth. Having thus concluded that gear teeth may fairly be considered as cantilevers loaded at the end, the influence of their form upon their strength remains to be disposed of.

In interchangeable gearing, the cycloidal is probably the most common form in general use, but a strong reaction in favor of the involute system is now in progress, and I believe an involute tooth of 22½ degrees obliquity will finally supplant all other forms. There are many good reasons why such a system should be generally adopted, but it is not my purpose at present to discuss the merits and defects of different systems of interchangeable gearing, and I now propose to explain how the factors given in the table herewith were determined by graphical construction.

A number of figures were carefully drawn on a large scale, to represent the teeth cut by a complete set of equidistant cutters, making the fillets at the root as large as possible to clear an engaging rack. See Plate I.

The addendum was .3 p, and root .35 p, as shown in the illustrations, and the clearance .02 p.

When the load is applied at the end of a tooth and normal to its face in the direction $a\ b$, it may be resolved into two forces, one tending to crush the tooth, and the other to break it across. The radial component which tends to crush the tooth directly has but a slight effect upon its strength. In material which is stronger in compression than in tension, the transverse stress due to the other component, W, is partially counteracted on the tension side, and the teeth are stronger by reason of their obliquity of action, but in material which is weaker in compression the reverse is the case, and, in general, it may be said that the strength of teeth will not be affected more than 10 per cent. either way by the consideration of this radial component.

It should therefore be understood that for the sake of simplicity the factors given have been determined only with reference to the transverse stress induced by the force W, which may be regarded as the working load transmitted by the teeth. This load is applied at the point b, but it does not at once appear where the tooth is weakest, and, to determine that point, advantage is taken of the fact that any parabola in the axis $b\ e$ and tangent to $b\ W$ at the point b incloses a beam of uniform strength. Of all the parabolas that may thus be drawn, one will be tangent to the tooth form, and it is evident that the point of tangency will indicate the weakest section of the tooth. In the rack-tooth of 20 degrees obliquity, this is found at once by prolonging $c\ a$ to its intersection g with the center line $f\ b$, and laying off $b\ f = b\ g$; and in other cases the weakest section $c\ d$ may be found tentatively to a nice degree of accuracy in two or three trials. Having found the weakest section, the strength at that point is also determined graphically by drawing $b\ c$ and erecting the perpendicular $c\ e$ to intersect the center line in e; $e\ f$ or x is then taken to measure the strength of the various forms of teeth.

To understand the reason for this construction and the actual relation which the distance x bears to the strength of the tooth, it will be observed that the bending moment $W\ l$ on the section $c\ d$ is resisted by the fiber stress s into one sixth of the face f times the square of the thickness t, or by the well-known formula for beams, we have

$$W\ l = \frac{s\ f\ t^2}{6}, \text{ or}$$

$$W = \frac{s\ f\ t^2}{6\ l} \qquad (1)$$

But by similar triangles

$$x = \frac{t^2}{4\ l} \qquad (2)$$

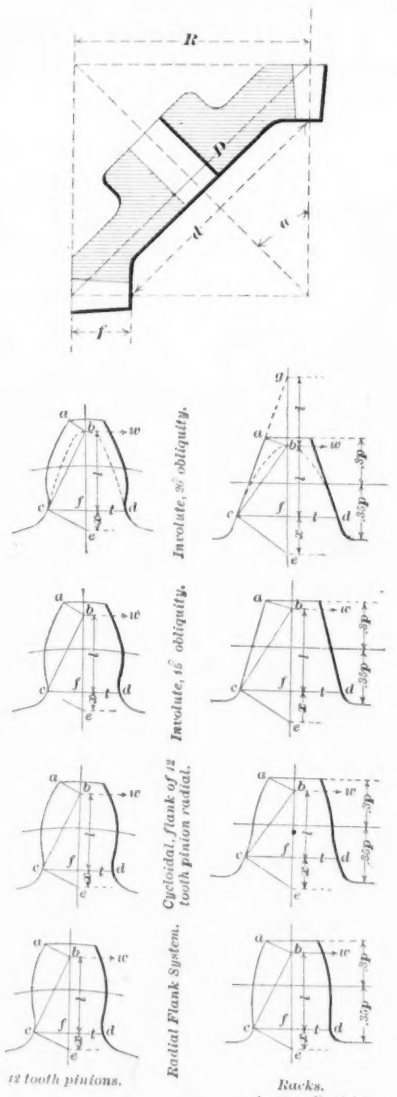
and substituting this value in equation (1) we have

$$W = s\ f\ \frac{2\ x}{3} \qquad (3)$$

or we may write

$$W = s\ p\ f\ \frac{2\ x}{3\ p} \qquad (4)$$

$\frac{2\ x}{3\ p}$ or y is the factor determined by graphical construction and given in Table I for convenient reference. This is multiplied by the pitch face and fiber stress allowable in any case when the working load W is to be determined. What fiber stress is allowable



Investigation of the Strength of Gear Teeth.—See Page 3.

under different circumstances and conditions cannot be definitely settled at present, nor is it probable that any conolusions will be acceptable to engineers unless based upon carefully made experiments. In the article referred to, certain factors are given as applicable to certain speeds, and in the absence of any later or better light upon the subject, Table II has been constructed to embody in convenient form the values recommended. It cannot be doubted that slow speeds admit of higher working stresses than high speeds, but it may be questioned whether teeth running at 100 feet a minute are twice as strong as at 600 feet a minute, or four times as strong as the same teeth at 1,800 feet a minute. For teeth which are perfectly formed and spaced, it is difficult to see how there can be a greater difference in strength than the well known difference occasioned by a live load or a dead load, or two to one in extreme cases. But, for teeth as they actually exist, a greater difference than two to one may easily be imagined from the noise sometimes produced in running, and it should be said, that this table is submitted for criticism rather than for general adoption. It is one which has given good results for a number of years in machine design, and its faults, such as they may be, are believed to be in the right direction from another point of view; for, when the durability of a train of gearing is considered, it would seem that all gears in the train should have the same pitch and face, because all transmit the same power, and are therefore subject to the same wear. But this argument is modified by the further consideration that equal wear does not mean equal life in a train of gearing, and a compromise between the considerations of life and strength must result in the adoption of values for different speeds, somewhat similar to those given in Table II.

TABLE I.

Number of Teeth.	Factor for Strength, y. Involute 20° Obliquity.	Involute 15° and Cycloidal.	Radial Flanks.
12	.078	.067	.052
13	.083	.070	.053
14	.088	.072	.054
15	.092	.075	.055
16	.094	.077	.056
17	.096	.080	.057
18	.098	.083	.058
19	.100	.087	.059
20	.102	.090	.060
21	.104	.092	.061
23	.106	.094	.062
25	.108	.097	.063
27	.111	.100	.064
30	.114	.102	.065
34	.118	.104	.066
38	.122	.107	.067
43	.126	.110	.068
50	.130	.112	.069
60	.134	.114	.070
75	.138	.116	.071
100	.142	.118	.072
150	.146	.120	.073
300	.150	.122	.074
Rack.	.154	.124	.075

TABLE II.

Safe Working Stress, S, for Different Speeds.

Speed of Teeth in Ft. per Minute.	100 or less.	200	300	600
Cast-iron.	8,000	6,000	4,800	4,000
Steel.	20,000	15,000	12,000	10,000
Speed of Teeth in Ft per Minute.	**900**	**1,200**	**1,800**	**2,400**
Cast-iron.	3,000	2,400	2,000	1,700
Steel.	7,500	6,000	5,000	4 300

To illustrate the use of Tables I and II, let it be required to find the working strength of a 12-toothed pinion of 1 inch pitch, 2½ inch face, driving a wheel of 60 teeth at 100 feet or less per minute, and let the teeth be of the 20-degree involute form. In the formula $W = s\ p\ f\ y$, we have for a cast-iron pinion,

$s = 8{,}000$, $p\ f = 2.5$, and $y = .078$,

and multiplying these values together we have $W = 1{,}560$ pounds. For the wheel we have $y = .134$, and $W = 2{,}680$ pounds.

The cast-iron pinion is, therefore, the measure of strength, but if a steel pinion be substituted, we have $s = 20{,}000$ and $W = 3\ 900$ pounds, in which combination the wheel is the weaker, and it therefore becomes the measure of strength. In teeth of the involute and cycloidal forms, there is a marked difference between racks and pinions in working strength, while in radial flanked teeth, which are used more especially on bevel gears, the difference is not so pronounced. These teeth are to be found in the great majority of all cut bevels, because they can be more cheaply produced on milling machines and gear cutters, but the 15 degree involute bevel tooth, as made by the Bilgram process, is superior in accuracy of form and finish, and is often preferred for patterns and fine machinery. There are, therefore, two well-defined forms of bevel gears to be considered; and to bring the strength of bevel gearing within the scope of the present investigation, it will be necessary to understand how the variation in their pitch and radius of action is allowed for, and without going into a demonstation of the formula, its simple statement will probably be sufficient.

Referring to the figure,

D = large diameter of bevel.
d = small diameter of bevel.
p = pitch at large diameter.
n = actual number of teeth.
N = formative number of teeth.
n = secant a, or the number corresponding to radius R.
f = face of bevel.
y = factor depending upon shape of teeth and formative number N.
W = working load on teeth referred to in diagram D.

Then it can be shown that

$$W = s\ p\ f\ y\ \frac{D^3 - d^3}{3\ D^3\ (D - d)} \qquad (5)$$

To illustrate the use of this formula, let it be required to find the working strength of a pair of cast-iron miter gears of 50 teeth, 2-inch pitch, 5 inch face, at 120 revolutions per minute.

In this case, $a = 45°$, $D = 31.8$, $d = 24.8$, and secant $a = 1.4$, $N = 50 \times 1.4 = 70$, for which $y = .071$. The speed of the teeth is 1,000 feet per minute, for which, by interpolation in the table, $s = 2{,}800$, and the formula becomes by substituting these values,

$$W = 2{,}800 \times 2 \times 5 \times .071 \times \frac{31.8^3 - 24.8^3}{3 \times 31.8^2\ (31.8 - 24.8)}$$

$$= 1{,}988 \times .795 = 1{,}580 \text{ pounds.}$$

This result is attained by some labor which is practically unnecessary, because d should never be made less than $\frac{2}{3}\ D$, and when this rule is observed, the approximate formula,

$$W = s\ p\ f\ y\ \frac{d}{D} \qquad (6)$$

gives almost identical results. The reason for fixing a limit to the ratio $\frac{d}{D}$ is found in the fact that a further increase in face adds very slowly to the strength and increases very rapidly the difficulty of properly distributing the pressure transmitted. Where long-faced bevels are used, the teeth near the shaft are generally broken by improper fitting, or, when properly fitted, by the spring of the shaft or the yielding of its bearings, and as the limit imposed gives about 70 per cent. of the strength attainable by extending the face to the center, it is thought to be as liberal as experience can justify.

In presenting certain forms and proportions for teeth, on which Table I is founded, I am aware that other forms and proportions are in common use, which have some claims to recognition, but my chief object at present is to show that the strength of gearing can be reduced to a rational basis of comparison on which all authorities may ultimately unite.

At a recent meeting of the Academy of Sciences a description of an instrument to show the small variations in the intensity of gravitation was read by M. Bouquet de la Grye. The instrument, which has been set up in a cellar of the Dépôt de la Marine, consists of an iron tank containing hydrogen confined over mercury, with three tubes leading out through the bottom. Two of these tubes are bent upwards to about 40 cm. above the ground. One of them is used for filling the tank with mercury, the other for letting in the hydrogen, which is accomplished by letting mercury run out through the third pipe at the bottom. The second pipe ends in a horizontal tube made of glass, through the walls of which the fluctuations of the column of mercury sustained by the elastic force of the hydrogen can be observed. By means of an alcohol thermometer immersed in the mercury on the top of the tank, changes of temperature of one-thousandth of a degree are indicated by a movement of 1 mm. The column oscillates with each change of temperature and each variation of gravitation, but is not affected by changes of pressure, since the tube is kept closed at the top. Under these circumstances the instrument in question is capable of indicating the change of gravitational force due to the change in the position of the moon by a displacement of 0.46 mm. *Nature* says the apparatus is difficult to set

up, and will require some improvement before it can give trustworthy results.—*The Engineer* (London).

The "Waterspout" Pulsating Steam Pump.

We show with this three views of this pump as made by the Waterspout Engineering Company, Salford, Manchester, England. Fig. 1 is a front view, Fig. 2 a back view, and Fig 3 a sectional view.

It consists of several castings. The main casting, or body, is provided with two working chambers, below which is the suction chamber, and in front is placed the delivery chamber. There are openings between the suction chamber and the two working chambers, which are provided with suction valves. Also in the walls separating the delivery chamber from each working chamber there are openings provided with delivery valves which allow the liquid to pass from the working chamber into the delivery chamber, and thence by means of the rising main to where desired. On each side of the body casting there are openings provided with suitable covers, which on removal admit of free and easy access for examination or renewal of the suction and delivery valves.

The head casting is bolted to the top of the working chambers, forming a continuation of the same, terminating in a triangular shaped steam chest, on each side of which are formed the steam valve seatings.

The steam valve is formed of two hollow hemispheres, joined together at their convex surfaces, in conjunction with a bearing or rocking bar. The flat surfaces of the hemispheres form an angle to each other, approximating that formed by the seatings in the steam chest, but allowing the requisite amount of play between the valve face and seating on either side of the chest, so that as it oscillates from side to side steam will be admitted alternately, first to one chamber then to the other.

The bearing bar rocks on a flat surface the full width of the steam chest, and in consequence of this large bearing surface the durability of the valve is materially increased.

To start and work the pump it requires charging with water. This may be done by filling it through the plug hole provided for that purpose, or by "drawing the charge," an operation which we do not quite understand. Steam is permitted to enter the steam chest by a pipe connected to the head, and passes through the port opening into the working chamber, and by its pressure forces the water out through the delivery valve to the discharge pipe. As soon as the level of the water is as low as the bottom of the inclined partition (below which the water passes to the delivery chamber) the steam rushes through with a certain amount of agitation, producing instantaneous condensation, through being brought into violent contact with the water. The vacuum thus rapidly formed pulls the steam valve over to the opposite seating, closing the steam port of the chamber just emptied, and preventing the further admission of steam, insures the completion of the vacuum. More water is then forced by atmospheric pressure up the suction pipe through the suction valve and immediately refills the just emptied chamber. While one chamber is filling the other is emptying, so that an almost continuous stream of water is discharged from the delivery pipe, and this continues so long as there is steam to work with and water to pump.

These pumps are used for a variety of purposes, pumping liquids containing large percentages of solid matter. In mines the fact that there is no exhaust is important; for crystallizing liquids there are no pistons to stick and corrode.

Fig. 1.

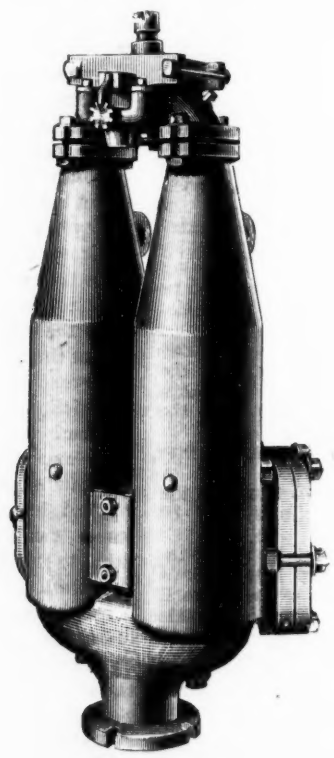


Fig. 2.

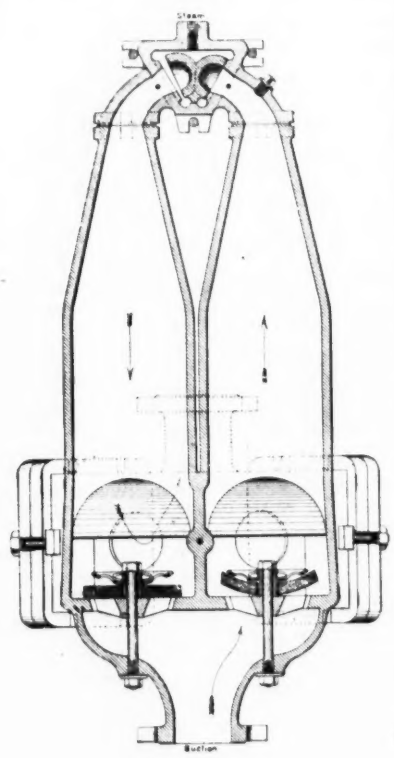


Fig. 3.

THE "WATERSPOUT" PULSATING STEAM PUMP.

LETTERS FROM PRACTICAL MEN.

Mushet Steel.

Editor American Machinist:

I noticed in the AMERICAN MACHINIST of February 23d C. E. Simonds' article on "Mushet Steel." I have had some experience in annealing this make of steel, and as far as my experience goes I am convinced that for heavy work on extra hard stock it will pay to use mushet steel for milling, drilling, etc.

I have made large twist drills of it, and can say they stand first-rate; in fact, enough better than ordinary tool steel to pay the extra expense. My way of handling it is to heat to a yellow heat, and cover with sawdust, this is again covered with lime; leave in till cold. I then rough out the drill, and when necessary anneal again, then finish. In tempering the drills I only temper the end, as this leaves the drill stronger toward the shank. In grinding, I find it better to give these drills less clearance than is usual with other steels.

Large milling cutters are easily made of mushet steel after one gets the knack of working it. For inserted tooth mills the teeth made of mushet steel stand much better than common steel. I have had no trouble in using oil in cutting it, and have also used water with success. The one trouble in working mushet steel is in annealing; this can be done, and after one gets the hang of it the rest is easy. I have just received a lot of this steel annealed by the manufacturers, who claim that they are prepared to furnish it soft enough to work into almost any tool. As soon as I have this lot worked up I will let you know the result.

There is one point to be guarded against, that is, thin edges and sharp corners; this is the reason it is unfit for small, light tools.

C.

Editor American Machinist:

Permit me to suggest that with a score or more of other "self-hardening" or tungsten steels in every-day use, *not "mushet," but equally as good*, it is time to do away with the fiction that all steel possessing sufficient initial hardness to be used for cutting tools without hardening is necessarily "mushet" steel. "English mushet," "genuine mushet," "American mushet," "imitation mushet"—these are terms in common use.

Now, why "mushet" at all, except as applied to the one imported steel entitled to the name, just as another steel is entitled to the name Jessop?

About annealing tungsten steel. No doubt it can be annealed, as stated by "A Reader," but why should it be? At the best it will not work as soft as a good carbon steel, hence costing more to make the tool; and for any use except rough work, tools for which can be forged and ground to shape, a good carbon steel of suitable temper, properly hardened, is the best anyhow. For lathe and planer tools, for rough work, which would draw the temper on carbon tools, self-hardened steel is very valuable, but it is neither as hard nor as strong as good carbon steel properly hardened, will not carry as fine cutting edge, and for clean cutting, at reasonable speed, which will not disturb the temper, the advantage is against the so-called "mushet." Why bother with annealing a steel which at the best will cost more to make into cutters, after having cost three or four times the price of a good straight carbon steel to begin with, to get tools of less value? S. W. GOODYEAR.

Standard Catalogues.

Editor American Machinist:

We have noted the communications in your columns relating to "standard size" catalogues, and we wish to add our indorsement to what is said by Messrs. F. E. Reed & Co., and others. There probably has never been a time when catalogues have been so generally used as the present, and it is becoming quite a question in many offices as to how best to dispose of the accumulation, so that they can most easily be found for reference.

In our office we have several hundred catalogues, ranging in size from the "easily lost" 3″x5″, to those wastes of paper 9″x 14″, and it is certainly a perplexing question with us, never as yet having seen the drawer or file that was just right for all sizes. How much work and vexation a uniform size would save. We heartily commend the idea to all manufacturers, and hope the question will be agitated until the desired end is attained.

L. W. POND MACHINE CO.

"Speed of Machinery."

Editor American Machinist:

In your April 6 issue I see that Mr. P. H. Bullock has something to say about the speed of machinery. Having been employed at one time for a number of years in setting up machinery in different parts of the country, I can well appreciate the trouble arising from not knowing what speed the driving pulleys on a machine should make, without first figuring it out through a train of gears, or belts and pulleys, for I have had similar experience to Mr. Bullock's, and determined that if I ever had a chance I would make these things plain from the start, not only making it easier for the man who should put the machines up, but also save some of the "cuss" words that might possibly be heaped on my head. For the last three years every machine leaving my shop has had a card like the inclosed stuck onto the face of driving pulleys, properly filled out;

> THESE PULLEYS ARE..... INCHES IN DIAMETER AND SHOULD MAKE.....REVOLUTIONS PER MINUTE.

it might perhaps be better to put them on in the form of a tag, so they would not fall off in case the "stickum" did not hold.

ALBERT L. COLBURN.

Treatment of Steel.

Editor American Machinist:

In your issue of the 23d inst. Mr. W. S. Goodyear's remarks on steel interested me very much. It is, I think, as he says, tool steel is much abused by machinists and tool makers in hardening and tempering it without any knowledge of the heat required. Steel makers make steel special for all kinds of tools. I should think it would be a good plan for the manufacturers to make a list of the different grades of steel and state what heat is best for each, and furnish their customers with a copy. This would be, of course, a little expense, but, think, in time it would do away with a great deal of abuse done the makers from the ignorance of men handling steel without a knowledge of it. I also think it would be a good plan for every firm using tool steel to have a card with the different steels they use and the proper heat they require hung up, tacked up, or in some way fixed at the gas furnace, forge or any place where the men are in the habit of hardening and tempering. As to taking a piece of steel and heating it and breaking it, to find if you have heated it right or not, this is better than making a nice tool and then practicing on it; but I think the above the proper way, if there is any proper way in this matter.

I think the producer and consumer would in a short time, if they adopted it, wonder how they ever got along without it. This idea may be a wild one, so I am willing, and, in fact, would like to hear anybody's opinion on it. E. W. FLINT.

The Wire Gauge Muddle.

Editor American Machinist:

So much has been written of late on this subject that it may have become tiresome to your readers, but if the discussion of the subject makes them tired they should feel a sense of relief at the bare possibility that a reform may be effected; this is the only apology the writer has to offer in entering the lists as a champion of a new standard gauge to replace the many *so-called* wire gauges now in use that have nothing to commend them to the mechanical public but their antiquity, having been introduced at a time when the now universally used micrometer caliper was unknown, and each gauge was created to meet the supposed needs of the maker for his particular line of work.

But when adopted by others, and becoming an article of manufacture, the trouble comes in distinguishing between the different kinds, and keeping each to accurate size. To keep in mind the different kinds and

know the size that each number represents, is what occasions the most trouble. A few days' experience in the tool room of any large manufacturing concern will convince the most skeptical of this fact, for here there is no end of inquiry as to the size of certain numbers of wire Then the loss of time explaining the difference between the different gauge sizes makes the inquirer tired as well as sorry he asked the question. Here is a sample to illustrate the difference in some of the gauges in common use.

Number of Gauge.	American or Brown & Sharpe.	Birmingham or Stubs.	W. & M., Worcester, Mass.	Trenton Iron Co., N. J.	G. W. Prentise, Holyoke, Mass.	Brass—Old English.	Steel Music Wire.	Morse Twist Drill and Steel Wire.	Miller, Metcalf & Parkins.
16	.05082	.065	.063	.061	.0627	.065	.0359	.177	.175

This is not the case with the standard caliper gauge, for no matter who the maker is the figures stamped on the tool give the exact size it will measure. While caliper gauges are made and are for sale in sets, say from ¼″ to 2½″ by 16ths, they are made in any sizes the purchaser requires. Gauges for drawing wire or sheet metal can be stamped the same way; then when a certain diameter of wire or thickness of metal is ordered there can be no doubt about what is wanted, and no delay in correspondence to clear up doubts before filling orders. In a circular issued in 1877 by the Miller, Metcalf & Parkins Co., Crescent Steel Works, of Pittsburgh, Pa., attention is called to this same subject, and after pointing out the trouble caused by trying to work to the wire gauges then in use they say: "There is a very easy way out of this whole snarl, and that is to abandon fixed gauges and numbers altogether. The micrometer sheet metal gauges made by the Brown & Sharpe Mfg. Co , of Providence, R. I., cost less than a common gauge or no more. They measure thousandths of an inch very accurately, and even a quarter of a thousandth may be neatly measured.

"We find that mechanics like to work to them, and that there is very little trouble to get sheet rolling done to them in a thousandth of an inch on fine sizes. Our works are fully supplied with these instruments, and we urge all parties in ordering to give us dimensions and not numbers. We cannot recall a serious case of complaint having arisen where we have had dimensions expressed in decimals to work to."

The above was good argument then when the micrometer caliper was in its infancy, while now the machinist's tool chest is not complete without one—so indispensable have they become. The micrometer caliper gauge may not dispense with fixed gauges altogether, such is not their purpose; the reform demanded is to do away with senseless numbers that require an expert to tell what they mean, and put on the size in decimals that every mechanic understands, wherever the fixed gauge is necessary to be used.

If the Committee of the American Society of Mechanical Engineers having this matter in hand will formulate a system which that body can recommend, they will deserve the thanks of all mechanics. D. D. D.

The Status of Engineers.

Editor American Machinist:

I have just read with great satisfaction your remarks on "Engineers and Mechanics" in the current issue of your paper. The subject of the status of the engineering profession is a live one, and it is becoming every day more and more evident to both the profession and the public, that some move must be made at once or we will remain open to just such insinuations as Mr. Burnham made in the speech which you refer to.

Had the engineering profession been organized as the profession of architecture is at present, engineers would not have been subordinated as they have been at the Exposition. There the architectural work was parceled out to the ablest architects in the country, but the engineering work has been designed and constructed by a corps of engineers and draftsmen on the grounds. While the architects were liberally remunerated for their work, the engineer was engaged at the lowest figure possible; architects with recognized ability and reputation were *sought*, but the engineers *applied* for their positions, and were informed that they were expected to work for glory.

You refer to my paper read at the meeting of the American Society of Mechanical Engineers last fall. If the suggestions therein outlined should be carried out, the present situation would be materially changed. This paper was the forerunner of a series of similar papers read before both national and local engineering societies on practically the same subject, and the technical press of both this country and others contains articles which show that the time is ripe for the organization of the profession.

Canadian engineers are leading us, however, and I am in receipt of a circular letter dated March 29, from the Canadian Society of Civil Engineers, which gives the following copy of a resolution submitted at their recent annual meeting:

"1st. That the time has come when the profession of civil engineering should be placed on the same footing as those of law, medicine and theology; that is to say, that no person should have the right to style himself a 'civil engineer' or to practice, or to be employed as such, unless he shall have been duly and authoritatively admitted and declared to be a properly qualified member of the profession by some regularly constituted body or corporation having powers corresponding to those enjoyed and exercised by the barristers' societies, the medical societies and the theological schools in this country.

"2d. That for the welfare of the country generally, and for the advancement, stability and elevation of the profession of civil engineering in Canada, these powers should be vested in the Canadian Society of Civil Engineers.

"For the furtherance of this object, therefore, it is earnestly recommended to the Council, and respectfully requested, that a committee be forthwith appointed from the Council and Society.

"(A.) To make a thorough inquiry into the matter.

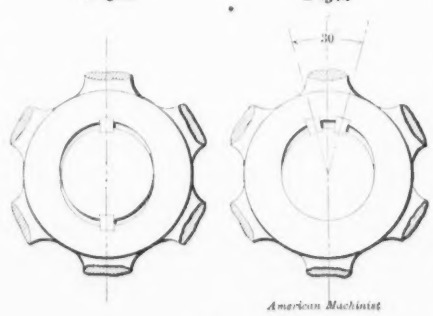
"(B.) To suggest means whereby the much desired professional status may be established, and

"(C.) To make a full report to the Council on or before the 1st day of November of the present year, in order that the Council may give due and full consideration to this important matter, and present it for further action to the annual meeting of 1894."

It is greatly to be hoped that some similar action will be the outcome of the Engineering Congress to be held at Chicago next summer, and I trust that you will lend the aid of your valuable columns to that end.

H. F. J. PORTER,
Asst. Chief Dept. Machinery.
World's Columbian Exposition, Chicago.

Fig. 1 *Fig. 2*



Keys.

Editor American Machinist:

Regarding the subject of the dimensions of keys lately discussed in the AMERICAN MACHINIST, there are other features concerning them quite as important, if not more so, than their dimensions.

Unwin says keys should fit at their sides even more accurately than at their top and bottom, which does not agree with my own experience, nor with that of some persons of large experience in this particular matter.

As for the size of keys I have a penchant for making them square when the conditions will admit; that is, making the thickness the same as the width, which would be one-fifth the diameter of the shaft. I can give no better reason for so doing than that advanced by those who adopt their own standard, that I like to do so because I have obtained good results when good workmanship prevailed.

In discussing the subject of keys with one of the best practical machinists, who is not given to publishing his experience, one who I knew to have been very successful in remedying a number of troublesome cases where keys had worked loose, he was of decided opinion that the best material of which to make keys was soft steel; that where a driving fit obtained, a good result can be had by simply flattening the shaft for about twenty-four degrees, and cutting the keyway in the hub; the thickness of the key need only be sufficient to withstand the driving and backing out.

That the fit of keys top and bottom was of much more importance than that at their sides.

That where the hub fits the shaft loose as a running fit, the result of keying will be uncertain and liable to give trouble. That it is of the utmost importance that the fit of the hub to the shaft should be a tight one to insure a reliable result.

He believed the modern practice where two keys are used of placing them opposite is not so good as the former practice of placing them at right angles to each other, and it is better yet to place two keys as close together as the nature of the work will admit of, because where two keys are placed near each other a greater amount of the circumference of the shaft is embraced by the hub than when they are placed opposite, consequently the holding power of the hub is increased, for the same reason that a belt increases its holding power on a pulley the more it encircles it. He said the tendency when the key is driven is to enlarge the hub. Figs. 1 and 2 illustrate this tendency in an exaggerated form.

As the foregoing conclusions are the result of the experience of an intelligent and observant mechanic, I regarded them worth chronicling.

Prominent in the reminiscence of my early shop experience is an instance where the keys in a paddle-wheel center frequently worked loose, the cause of which, I presume, was that the center was originally fitted to the shaft too loosely, which allowed it to work on the shaft and upset the keys. Engineers are aware that it requires a first-class job of keying the wheels to enable them to withstand the shocks resulting from the sudden stoppages and reversals to which side-wheel steamboats are subject.

A side-wheel boat which plied the Chesapeake would frequently arrive in Baltimore in the morning with loose keys in one of the centers of the wheels. As a cub in the pattern shop it devolved upon me to go into the paddle-boxes, and fit the wooden patterns for new keys. Each succeeding new set became more difficult to fit in consequence of the center moving on the shaft, and its keyways overlapping those of the shaft. As the job had to be completed in time for the boat to leave in the afternoon, we were compelled to hustle and not allow any kind of weather delay us.

This fitting new keys went on until an accident occurred which, under most circumstances, would be regarded as unfortunate, but in this instance proved to be fortunate as well for the company as for the pattern shop cub, as it relieved the company of an annoyance and the cub of many a disagreeable job.

The broken shaft was replaced by a new one, which offered the opportunity to make a tight fit of the center to the shaft, after which there was no further trouble with loose keys. I. MCKIM CHASE.

The safest railways of the world are those of Northern Germany, where every inch of the track is kept, night and day, under the surveillance of Government officials. In the Alps accidents are at least twice as frequent, and the championship of recklessness may be disputed by the countries of the lower Danube and the Southwestern States of our Union.—*Cincinnati Tribune.*

Shop Notes.

Editorial Correspondence.

One of the most notable establishments in Torrington is that of the Excelsior Needle Company whose new shops and office building constitute one of the best arranged, and largest manufacturing plants in the place. Needles for practically all the sewing machine companies are made here and at the company's other plant in Springfield, Mass.; and the Torrington plant having been erected after the system of manufacture was well developed, and when there was no lack of capital, is a model in its way, and is filled with the most interesting machinery and appliances imaginable. But though courteously received and accorded the very pleasant privilege of an inspection of the factory in company with Mr. Dayton, who is the mechanical head of the concern, I found that the processes employed here are somewhat guarded from public observation, and that they preferred to have nothing published regarding them. The cold swaging machine, however, by which the needle is drawn out from a much shorter piece of wire about the size of the shank may become shortly the subject of an illustration in our columns. In building these and other special machines used in the work a machine shop of considerable size is kept busy, a part of its work at present being the building of machinery and tools for a new establishment known as the New Process Nail Company, which is engaged in the manufacture of

HORSESHOE NAILS.

I think very few mechanics who have never given attention to the subject would suspect the amount of mechanical science which may be employed in the production of a good horseshoe nail, and a conversation with Mr. Miner, who is the mechanical head of this establishment, and a well-known mechanic, head of the firm of Miner & Peck, of New Haven, is not only very interesting, but something of a revelation. He has spent his life in studying manipulations of metal, cold and with the assistance of heat. In the present enterprise the work is done cold, the only use of heat being to anneal the stock at a certain stage of the process to remove the hardness caused by the cold swaging.

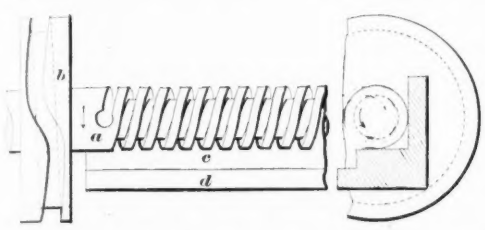
The stock comes in the form of coils of Swedish steel wire which is low in carbon. These have been annealed after drawing and the wire is therefore black. It goes to an ordinary heading machine which straightens it, cuts it off into lengths of about 1½ inch, and forms a rounded head upon them. They are then tumbled to brighten them and dumped into a shallow revolving pan from which a forked oscillating lever picks them up, carries them into suitably inclined guides and feeds them to a gripping device which automatically carries them forward to the dies of a swaging machine which swages them out to a tapering form resembling that of a bodkin, and about 3 inches long. At the end of this operation the blank presents a finely finished surface, and is quite hard and stiff, so much so that for the subsequent operations and to give the finished nail the proper degree of stiffness it is annealed, this being done by the Jones annealing process which is controlled by the Jones Annealing Process Company, of Hartford.

The process consists essentially of first inclosing in a wrought-iron pipe, iron cuttings, chips or scale; heating this to redness in a suitable furnace (which in this case uses petroleum as a fuel) and passing air through the interior. In passing through, the oxygen of the air is all taken up in oxidizing the contents of the pipe, the gas which remains and which is entirely free from oxygen, and therefore incapable of oxygenizing or rusting a metal is passed on to a suitable tank in which it is kept for use. When articles are to be annealed, they are placed within the same pipes; the air driven out and replaced by this de-oxidized gas, and the heating is done as before. Although the blanks in this case are kept at a red heat for

some time within the pipe they are as bright and clean when they are taken out as when they go in, unless the pipe be unsealed before their temperature has been sufficiently reduced to prevent the oxidation which ordinarily appears as temper color, and when this happens the color is very brilliant and uniform. Tool steel used about the place is annealed in the same way, and it is such annealing as delights the heart of the tool maker who has been accustomed to the usual apology for annealing which has to be endured in most shops.

The slight variation in size of wire, which so far seems to be unavoidable, reveals itself very plainly in the varying length of the blanks after the swaging process. The small end being something like $\frac{3}{64}$ inch in diameter runs through the dies more or less according as the wire is larger or smaller in diameter, and this extra length has to be trimmed off, and is the only waste of stock involved in the process.

As the blanks come from the annealing process they are placed in a feeding device which drops them one by one on top of a revolving square-threaded screw which with its attachments devised by Mr. Dayton constitutes a mechanical contrivance that seems to be new. Its principle and method of operation will be understood from the sketch, in which *a* is the screw and *b* a cam keyed to the end of it. As a blank comes



down to the screw the head is engaged by the hole at the end of the thread next the cam, and the screw revolving in the direction of the arrow the head of the blank is then carried by the motion of the screw over onto the surface *c* and pushed over on this to the vertical surface *d*, both these surfaces being parallel with the screw. This goes on until each space between the threads of the screw is filled by a blank, the friction between them and the screw threads keeping the heads against the vertical surface *d*, while the motion of the screw carries them along to the right. This is not done uniformly, however, owing to the cam at the end of the screw. In the groove of this cam a fixed roller engages and the screw is free to move endwise in its bearings by the action of the cam; this movement during most of a revolution being just equal to that of the spiral of the screw threads, but in the opposite direction, so that although the screw revolves the threads do not travel endwise. But the cam groove is so formed that all this movement is concentrated into about one-tenth of a revolution, during which the screw is moved in the direction of its spiral a distance equal to the pitch, so that the motion of the blanks instead of being uniform consists of alternate dwells and movements, notwithstanding that the screw rotates uniformly. The various operations are performed upon the blanks during these dwells. The first of these is the cutting to length before referred to, and the second is a swaging of the extreme end down to a point. They then go on to the end of the screw where they are shoved by a finger onto a flat die, and by a toggle-joint press, made by Miner & Peck, flattened on opposite sides. Another finger then shoves the finished nail off the die, and it is ready for boxing. The nail when finished is a most admirable mechanical product. It is well finished all over, every nail is necessarily precisely like every other one, and the shape has that definiteness and regularity of outline which to the eye of the mechanic is always pleasing whether it be in the form of a horseshoe nail or a more complex object. An important attribute of such nails is absolute homogeneity so that there shall be no danger of its splitting within the hoof and laming the horse. This seems to be fully secured by the process, and I saw nails indiscriminately selected from the stock, punished in every possible way in the vise and with a hammer without showing the least sign of an inclination to split or break.

At the suggestion of some persons connected with the U. S. Patent Office Mr. Miner has prepared for exhibition at Chicago a large frame within which are arranged in groups specimens of all the leading horseshoe nails that have been made from time to time in this and foreign countries, and accompanying this will be a history of the development of the art of making them, which has also been compiled by Mr. Miner. About 150 patents have been taken out that pertain to the making of horseshoe nails, and about 10,000 tons of them are made per year.

WATERBURY.

A short distance from Torrington is Waterbury, whose fame as a manufacturing town is world wide, and where are made a great many of those curious articles of manufacture which seem to be almost indigenous to the soil of this region, and are not so successfully manufactured anywhere else. Children here seem to breathe an atmosphere of things mechanical, and when they get large enough take to the factories naturally. There are those who believe strongly in inheritance of mechanical ability, but whether the people of this region inherit their ability in that line or not they certainly hear much of mechanical matters, and become more or less familiar with them from the time they begin to talk and to understand spoken language. It is to be expected that such children will, when old enough to work, readily learn to perform mechanical operations, and where special talents exist, become successful mechanics. So far as machinists are concerned, there are probably relatively very few of them in Waterbury that know much, if anything, of such work as is done on engines, locomotives, and the general machinery which is familiar to the public, but on die work and machines for utilizing dies of all kinds in the production of the curious and ingenious articles in sheet metal and wire that originate here they are highly skilled, and the work is mostly of a very high grade. Fairly representative of the machine work done is that found in the shop of

BLAKE & JOHNSON

who make a specialty of furnishing machinery for the automatic production of all sorts of queer things in wire and sheet metal. For instance, such an article as a safety pin will be made by one of their machines from the coil, the wire being straightened, given the ten or more bends that may be required for bringing it into shape, pointed and the point put in its proper place within the shield, all this being done continuously and entirely automatically. Hooks and eyes also, which possess "that hump" to which the attention of the feminine portion of the community is directed by the advertisers, are made on these machines, and if incidentally the article to be made requires that a thread be cut upon the wire, or a few holes punched through the strip of metal, this is also done and at a rate which is astonishing. They also make here drawing presses and rolls for working sheet metals, and as it sometimes happens that machines are constructed for use in establishments where the necessary skill for the management of such machinery has not been developed, and seems unlikely to be, a contract is sometimes made by B. & J. to take the machine and operate it in their own factory, and from this quite an extensive branch of their business has grown up which is carried on in a separate establishment, and where a part of the machinery belongs to the firm, and is used in filling contracts for work, while the rest of it has been built for and belongs to others who for the reason stated above have found themselves unable to operate it efficiently. Of course this latter condition only arises where machines are put into establishments that employ no machinists or tool makers, and who usually think that about all an automatic machine requires to make it work successfully is to be belted up and started.

The machine shop in which the machinery is built is a new building 200 by 45 feet, and three stories high. It is of brick, and contains all the latest improved shop features, including the Sturtevant hot blast heating and ventilating system, well-arranged wash room, places for clothing, and the best sanitary arrangements. The wash room is located in the basement, the most of which is used for a store room, and is so finished and arranged as to be dry and comfortable.

In this basement is an opportunity to see, above, a floor which is in some respects remarkable, and seems to be all that could be desired for a machine shop floor on which to place and build moderately heavy machinery. On suitable masonry foundations below the floor of the basement are placed posts 12″ square and 8 feet apart each way; on these are stringers which are 12″x14″, and above these floor joists 5″x8″ and placed 12″ apart center to center. On these are laid diagonally planks 3″ thick, and above these a covering of matched maple. Such a floor is undoubtedly very solid, and it doesn't seem to make much difference where machinery of moderate weight may be placed upon it.

The power plant here is a model in its way, consisting of a Brown engine which stands on a foundation extending from below the basement floor to the level of the shop floor, and accessible on every side. In the basement is fitted up a bath-room for the use of the engineer. About fifty men are employed here, including a draftsman and two pattern makers who are also draftsmen, and when occasion requires leave the pattern work and go into the drafting room. Mr. F. B. Manville, who is in charge of the establishment, thinks that by this plan of employing pattern makers who are also draftsmen, there is a decided advantage on such work as he is doing, aside from the convenience of being able to make transfers from one department to another as the work requires. The men are the better and more efficient pattern makers for being also draftsmen, while on the other hand their knowledge of pattern making is of great advantage in the drafting room.

Mr. S. W. Goodyear, who occasionally favors us with a communication on steel and its working, lives in Waterbury, and spends most of his time here and in the surrounding manufacturing towns as a missionary, whose especial mission it is to convert the benighted people who think that none but foreign steel is fit to use, and show them that American steel makers can also make good steel, and especially that a steel maker who is on the ground and has a chance to study the requirements of each case and adapt his steel to them, has a very good chance of being entirely successful. The relation of some of his adventures in teaching this great truth is very interesting, and it is evident from what may be seen during such a short tour of the shops as I was able to make with him that he is meeting with a good measure of success in the work. Mr. Goodyear also makes a specialty of machinery for pointing and swaging wire, his machine for this latter purpose having been previously referred to as in use at the Crescent Steel Works for finishing polished drill rods. At present he is having his machines built at the shops of the Waterbury Farrel Foundry and Machine Company, where the heaviest machine work of the place is done. They build here a rivet heading machine which works by a toggle joint that works an equal distance each side of the central line, and thus makes two strokes of the heading die for each revolution of the crank-shaft, and some of these machines are built to do much heavier work than is usually done by upsetting metal cold. They also build very heavy drop hammers, rolling-mills and other metal working machinery. Among other things they have constructed about 150 machines for making cigarettes, among them a number for making a brand which is "strictly hand made," according to the advertisements of them.

At the Waterbury Clock Company's works, where they are at present turning out about 1,500 clocks per day, there is much to be seen that is of interest, especially in the way of tool work, which is very finely done. In one room forty-five automatic screw machines are at work, making not only the screws but many other of the small parts of clock movements which in the old days were made on hand lathes of special design. Some of the work must, of course, still be done in this way, the tools used, however, not being the usual hand tools, but tools set in a square bar of steel, the ends of which are turned cylindrical for some distance and rest in supports upon which the bar slides along to take the cut, the tool in action being supported upon a rest which is placed near the work. The various tools are held in the bar by set-screws, and are adjusted in it to give the proper diameters of the various parts of the piece operated upon, and the bar turned from one tool to another does the work very rapidly.

An interesting line of work is being developed here at present which is the outgrowth of the fact that the company found that one of their smaller sized clocks was being carried by many people as a watch. It was, of course, rather large for this purpose, but the fact that it was so used led to its being modified, particularly in the way of reduction of thickness. The result of this is that the time-pieces are now being made so that they can be used either as clocks or as watches, and the system by which they are made admits of their being sold at retail at $1.50. They are neat in appearance—rather large to be carried in the pocket of a full dress suit, it is true, but very acceptable for many uses, and I can, within reasonable limits, give no better idea of the efficiency of the processes by which they are made than to state, as I have done, the retail price, which includes, of course, about three profits above the actual cost of manufacture.

The name of the Waterbury watch is associated in the minds of many people with extreme cheapness and a quality of work in keeping with the price. The factory and its equipment, however, are mechanically of a very high grade. The original factory was contracted for from the foundation of the building to its complete equipment in working order by the American Watch Tool Company, of Waltham, and as might be expected the contract was carried out in the best possible manner; the shop, its equipment of tools, the arrangement of them and of the tool rooms, store rooms, power plant, etc , being very admirable, as is also the cleanliness, order and evidence of good management that pervade the place. The original Waterbury watch, however, which the boys in the shop used to wind up by holding the stem against a running belt, has been abandoned and various higher grade watches are now made which are cased in any desired manner, the company claiming the distinction of now producing the thinnest full sized watch made. In one moderate sized room of this factory are small automatic and other machines to the value of about $125,000. F. J. M.

The first of a series of important armor plate experiments took place on April 7 at Portsmouth on board the "Nettle"; a plate cast by Messrs. John Brown & Co., of Sheffield, and treated by the Tressider process, being tried. Five rounds were fired from a 6-inch gun, the charges ranging from 36 to 42 pounds, with the result that four shots penetrated, but made clean holes, which could easily be plugged. The first shot, a Holtzer, with a 36 pound charge, broke on impact. One fired with a 42-pound charge penetrated the bulkhead of the "Nettle," as well as the backing. Numbers three, four, and five lodged in the backing, the two last being Pallisers. The trials were under the direction of Mr. W. H. White, Director of Naval Construction, and Captain Pearson, of the "Excellent" Gunnery School, and were watched by a representative of Messrs. John Brown & Co., and Captain Tressider.—*Iron.*

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A Hint to Foreign Subscribers.

The attention of foreign subscribers who desire to remit to us by international post-office money order is called to the importance of notifying us by mail direct at the same time that they have made such a remittance, and informing us of the purpose for which the money is intended. Serious delay and confusion are liable to result if the person making the remittance depends upon the post-office authorities to inform us from whom the remittance comes. In several recent instances the New York Post-office authorities have been unable to decipher or give us the sender's name and address, and in the absence of any instructions from the sender we have been unable to meet his wishes until the receipt of a complaint made several weeks afterward showed us who he was. A postal card is sufficient to give us the desired information. In all cases the exact name and address should be plainly written.

It is to be hoped that some day the countries of Continental Europe will amend their postal money order arrangements by adopting the duplicate blank system now in use in this country, Canada and Great Britain.

The Disastrous Rebound.

When the engineer of a locomotive running on the ordinary surface roads carries the water too high in his boiler, about the only immediate result is to make his engine look badly, and to waste fuel. The engineers on the elevated roads in this city have, however, other reasons for not carrying the water too high, and among these is the fact that the vacuum brakes refuse to work if water instead of steam passes through the jet which exhausts the air; instances having occurred where there was a failure to stop owing to the fact that the water was so high in the boiler that the brakes could not be worked. It would be a good thing, perhaps, if there was something about the ordinary locomotive which would make an equal amount of trouble with high water. An engineer who may do almost anything else, and be forgiven, must not, under any circumstances, scorch his crown sheet. That is the one thing which is considered above everything else to be disgraceful and unpardonable under any circumstances. It follows naturally that an engineer who has once "scorched her a little," and had a scare in that direction will chronically carry water too high for a long time, if not always afterward, and by the waste of fuel thus caused, as well as by the injury to the engine, cause more loss than would result from an occasional scorched crown sheet.

The same thing in a different form is noticeable in the work of machinists. If a bearing gets hot or becomes scored through neglect, the loss is likely to be still further augmented by the almost inevitable flooding of this and all the other bearings, for which the same man is responsible for a long time afterwards. If a piece of work gets loose from the planer bed and is ruined, the loss from this does not stop there, but goes on in the form of superfluous fastenings and excessively strained bolts, either by the man who meets with the accident or by others who may have witnessed it.

The same trait of human nature manifests itself among those who are not mechanics. A short time ago a man went into a Western manufacturing town, and organized a company to manufacture some specialties upon which he held patents. He took, as pay for his interest in the patents, stock in the new company, and gave out that he was to reside there and work in the interest of the new enterprise. The business men of the place subscribed freely to the stock, and there was little trouble in getting the new factory in operation. No sooner was this fairly accomplished than the stranger sold his stock for sufficient to pay him well for his work and left the company to discover the fact that they had only a shop right to manufacture the articles, and not the exclusive right, the sharper having presumably gone elsewhere to repeat the operation. Not long after this a young engineer who had for years lived and worked in the same town, invented an improvement in the line of work in which he had been engaged, and endeavored to form a company there to manufacture it. There was every reason to believe that the new invention would be successful; that it could be made at a profit, and that the engineer could be relied upon to devote his time and abilities to the success of the proposed enterprise; but nevertheless he was entirely unable to make any arrangement which would be at all fair to himself, and was compelled to go elsewhere, for no other reason, apparently, than that the capitalists had been recently deceived, and were suspicious and panicky.

The saying that "a burnt child dreads the fire" is founded upon human nature, but those who are no longer children should try to school themselves, so far as possible, to realize that though the fire may disastrously burn, it may still be used to advantage; and fearlessly used so long as it is used intelligently, and that one or even a dozen palpable mistakes in its use do not prevent its rational and safe use afterwards.

The Persistence of Humbug.

Some time ago an English electrical journal exposed the humbug of a widely-advertised electrical or magnetic belt which was being sold to the gullible public as a universal panacea for about all the ills that flesh is heir to. The company making the belt took up the matter and went into court with it, and were gloriously beaten, the paper proving conclusively that its charges of utter worthlessness and unadulterated humbug were nothing more than sober truth. The *Evening Post* of this city thereupon suggests that our electrical journals in like manner expose the electrical humbugs we have among us, and whose name is legion. This might be done, it is true, for the sake of abstract truth, but does the *Post* suppose it would actually diminish sales of such stuff very materially? Does the general public pay any attention to the warnings of experts in such matters? Would the average country newspaper, with a good paying advertisement of an electric belt displayed in its columns, print as news the fact that an electrical journal had exposed that belt as a humbug? And if not, then how is the great body of electric belt buyers to be reached? They do not read technical journals.

The patent medicine manufacturers can give the electrical belt men points on humbug, and their humbug has been and is being constantly exposed. The business seems to thrive upon such exposure.

What intelligent person does not know, for instance, that physicians keep lists of patent medicines giving their constituents that they may know how to deal with patients who have been taking them? Who does not know that the old reliable Mrs. Losehigh's soothing syrup that gives "rest to the mother and health to the babe" is mainly morphine, and highly injurious in many ways? Yet people continue to buy it, and assist their children in the formation of the morphine and alcohol habit. There are people who seem to prefer to be humbugged, and who will be, in spite of all that technical journals can do to prevent it.

A Combination Specialist.

A recently concluded murder trial in New York has brought prominently forward a new kind of specialist—a lawyer who is also a physician, able to cope with the expert testimony of learned physicians on the other side, and to handle the expert testimony of his own side to the very best advantage. The brilliance of his conduct of the case has attracted very general attention to him, and there is little doubt but that a successful career awaits him. It has occurred to us that in this might lie a hint to those who feel disposed to devote some study to engineering and the science of mechanics, afterwards taking up the law. An approach to this is made by those who are primarily mechanics and engineers, and afterwards take up the study and practice of patent law; but there is a good deal of litigation in which mechanics and engineering are involved, but not patents, and in such cases the lawyer who possessed some actual knowledge of the subjects in dispute would obviously have a decided advantage. A knowledge of engineering in the brain of one man, and a knowledge of law in the brain of another can never be combined and used in a trial as effectively as if the knowledge of both were possessed by one man. The latter will always be best able to combine and balance the points of the one science with those of the other, and to use both to the best advantage. Of course, this does not open a career for very many men, and in fact not many have the brain capacity with opportunity and disposition for study needed; but there are some men undoubtedly who could come as near mastering both professions as Dr. O'Sullivan has to mastering those of medicine and law, and such a man would have all the advantage possessed by those rare men who in manufacturing operations combine the mechanical with the commercial faculty.

Literary Notes.

VADE MECUM; a work of reference for the use of architects, architectural iron workers, builders, blacksmiths, book-keepers, boiler makers, contractors, civil, mechanical, hydraulic, mining, stationary, marine and locomotive engineers, foremen of machine shops, etc. Compiled and arranged by D. B. Dixon. With a comprehensive treatise on electricity, by Thomas G. Grier.

This work is similar in character to many of the engineer's pocket companions, but it is not confined to any particular profession; it covers a larger field, so that it will be useful to all those having to do, either directly or indirectly, with the various mechanical arts and trades.

The book has been compiled from scientific and mechanical sources, and contains much useful matter and valuable tables. It is to be regretted, however, that some of the pages indicate haste or carelessness. On page 67, for instance, it is stated that the horse power of double belts is 10.7 of that given in the table (single belts). This is evidently wrong; the transmitting efficiency of double belts of the average thickness is to that of single belts as 10 is to 7. On page 140, in the rule for finding the size of drill for drilling a hole to tap a full standard V thread, accuracy has been sacrificed for simplicity; the size of drill found by this rule will be too large. On page 150 a rule is given for finding the area of a steam engine cylinder, the horse-power, steam pressure, and speed of piston being given; here we are informed that the square root of the area of the cylinder will be its diameter; this is evidently a blunder. On page 152 a table is given for proportioning a few parts of a locomotive engine. A table of this kind should not find a place in this or any other book; it is, to say the least, misleading; the area of the steam ports does not depend on the diameter of cylinder alone, but it also depends on the piston speed.

The diameter of the driving axle does not depend wholly on the diameter of the cylinder, but it depends on the weight and speed of engine, and on the number of driving axles under the engine.

The electrical department of the book is very concise, and what there is of it, is plainly stated, and useful to practical men.

The mechanical department needs a revision, and after that the book will undoubtedly find a large sphere of usefulness, and will be appreciated by those who have occasion to refer to it.

The book contains 480 pages, 7¼x5 inches; it is clearly printed and well bound, and is published by Laird & Lee, Chicago, Ill. Price, $2.50.

"KEEP'S TESTS" FOR CAST IRON.

Mr. W. J. Keep has published in pamphlet form the full description of his system of testing which we gave to our readers early in the present year. Though there is in this pamphlet little if anything not to be found in our columns, it places the whole

matter together, and in a very convenient form for filing and reference.

In a private letter Mr. Keep informs us that foundrymen and others interested in foundries are evincing great interest in this system of testing, and that he receives many letters of inquiry regarding it, which is encouraging as showing the probability of an improvement in American foundry work —a branch of industry of which we have already good reason to feel proud.

We can scarcely resist the temptation to call attention to the fact that had Mr. Keep's pamphlet been about ½" wider and 1" higher, it would have been standard size, 6"x9", and, so far as we can see, there was nothing to prevent its being this size. Our readers may suspect that standard size catalogues and pamphlets is our hobby at present, but if so, it is a good hobby, and the indications are that the standard size will be almost universally used by machine builders and engineers in due time. The pamphlet in question, however, is a valuable one irrespective of its size, and all who are interested in foundry work should possess a copy of it. It will be mailed to those interested in the subject on application to the author, W. J. Keep, Detroit, Mich.

THEORY OF STRUCTURES AND STRENGTH OF MATERIAL. With diagrams, illustrations and examples. By Henry T. Bovey, M. A., D. C. L., F. R. S. C.; Professor of civil engineering and applied mechanics, McGill University, Montreal; member of the institution of civil engineers; member of the institution of mechanical engineers; late fellow of Queen's College, Cambridge (Eng.).

The work deals principally with the strength of material, and the strength of members of various structures, such as roofs, bridges, arched ribs, etc. It is a well-arranged text-book and will undoubtedly find its way into many class rooms; it may also be used with advantage by many professional engineers as a book of reference. It is published by John Wiley & Sons, 53 East Tenth street, New York. Price, $7.50.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(215) T. C. D. M., Philadelphia, Pa., writes: Kindly advise us of the best means of welding the ends of the same piece of wire together quietly so as to form a ring. Is there a machine made to do the above work? Will the electric process do it? *A.*—The electric process we believe to be the most satisfactory one for performing the work under the conditions named.

(216) X. Y. Z., Winona, Minn., writes: Is it necessary to procure expensive or special machinery to test such work as pulleys, etc., to ascertain if they are correctly balanced when running at their proper speed? Every repair shop of which I have any knowledge tests such work on a standing balance, which on fast running machinery is not effective. We want the simplest way for procuring a running balance. *A.*—The simplest way of obtaining the running balance of rotating parts of machinery is to get a special machine for the purpose. In our issue of January 12, current volume, you will find one illustrated and described which we believe to be a good one.

(217) W. B., New York, writes: Please inform me if an applicant for boiler inspector in the U. S. marine service has to undergo an examination, and if so, if there is any book or pamphlet issued that you know of that I could get for self-instruction in the matter. I am a competent mechanic, and have worked at the boiler-making business for the past twenty-two years. *A.*—You will have to pass an examination. We do not know of any book which contains the questions asked in the examination, and believe there is none. The questions are such as to test the fitness of the applicant for the position. The applicant must be well informed on matters relating to his business, and be able to answer any questions relating to the same; and besides this he should have a fair theoretical knowledge of marine engineering. You will undoubtedly be well treated by applying for any other information at the office of the Supervising Inspector in the Post-office Building of this city.

(218) J. M. S., Coahuila, Mexico, writes: The two accompanying samples of boiler plate were cut from a 56-inch by 16 feet tubular boiler. They are a part of a plate about one foot in front of the fire arch. You will notice that the plates have been acted upon by some substance which has destroyed the inside, as shown by one of the samples, while the outside has been crystallized only; and the other sample shows that the chemical action has penetrated the entire thickness. Please give a cause for the destruction of the plates. *A.*—In our opinion the samples do not show any chemical action; they have the appearance of having been in use for a some time, and probably have been a little overheated; we are also inclined to believe that the iron was not of the best quality.

(219) T. P., ——, writes: In your issue of October 16, 1890, an elliptic gear cutting machine is described involving the principle of the trammel. There are some points which I do not understand: 1. How are the two trammel pins made to move uninterruptedly in the slots in the stand? It seems to me that when one of the slots in the stand comes in line with the cutter, the elliptic gear blank or work will move away from the cutter. *A.*—The illustration referred to shows the principles of action only, and all details not essential to indicate the principles are omitted. The two trammel pins are fixed in the base; by placing a cap of suitable length on each pin, so as to allow the caps to work freely in the slots of the stand, the latter can be made to move uninterruptedly on the pins, and hold the gear blank in place, but we presume that clamps are used for further security. 2. How is the stand held to the base? *A.*—We suppose it is clamped to the base. 3. Is the post fastened to the index plate? *A.*—Yes. 4. Is the index plate evenly divided around its circumference? *A.* Yes. 5. Has a fuller description of this machine been given in the AMERICAN MACHINIST? *A.*—No; for any further information we should advise you to write to Geo. B. Grant, Lexington, Mass.

(220) A. W. S., Auburn, N. Y., writes: The accompanying drawing shows the ends of two traction engine axles drawn to the same scale. We have had somewhat of a discussion as to the comparative strength of the two axles; one you will note is straight uniform turn throughout; the other is reduced in size at the end. The hub of the wheel bears not upon the entire end of the axle but upon parallel portions. We desire to have your opinion as to just the strength of the two axles. The face of the wheel is 11 inches, and you understand the machines do not move over smooth roads, but very rough and stony roads, as a rule. *A.*—We presume that the hubs of the wheels run against the collars *a*, and that the lengths of the hubs are equal; we also assume that the bearings are of equal lengths, and that distances from the collars to the bearings are equal. Under these conditions

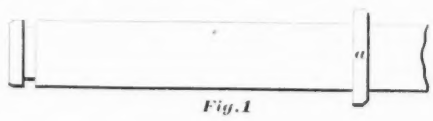


Fig. 1

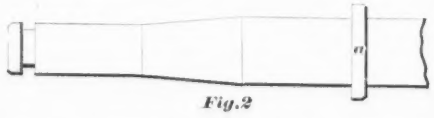


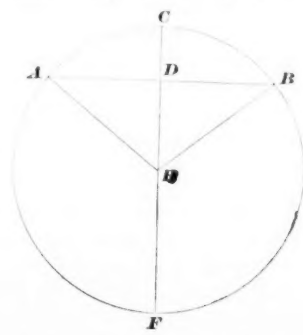
Fig. 2

the dangerous section of the axle is at the inner face of the hub of the wheel; now, since the diameters of the axles at these sections are equal, and since the bending moments are also equal, one axle will be as strong as the other. These remarks refer to strength only, that is to say, if the axles are stationary both can bear the same quiescent load at equal distances from the end. But the tapered end, Fig. 2, will deflect a little more than the straight end in Fig. 1, and therefore the axle in Fig. 2 has, so to speak, an inherent elasticity which, in our opinion, is of some advantage in running over a rough or stony road, because this elasticity will reduce to some extent the effects of the shocks and reduce the liability of the tapered end to break near the hub of the wheel.

(221) W. S. K., Chicago, Ill., writes: I wish you would give me the shortest and correct way of computing the area of a segment of a circle when its chord and height are given without any other dimensions; for example, to find the area of the steam space above the water line in a cylindrical boiler. *A.*—The rule for finding the area of a segment with the dimensions as given above is not a very short one, it involves considerable labor, although not difficult for any one who has a fair knowledge of geometry. To make the computation plain we will take the following example: The height $C\,D$ of the segment $A\,B\,C$ is 14 inches, its chord $A\,B$ is 43.6 inches, find its area. The first step will be to find the radius $A\,E$. To do so square one half the chord $A\,B$ and divide the result by the height, the quotient will be the distance $D\,F$, adding $C\,D$ to this we have the diameter. One half the chord is equal to 21.8 inches, and

$$\frac{21.8 \times 21.8}{14} = 33.94, \text{ say}$$

34 inches for the distance $D\,F$; adding 14 to this we have 48 inches for the diameter of the circle or 24 inches for the radius $A\,E$. The next step will be to find the number of degrees in the angle $A\,E\,B$; to do this we find the sine of half this angle, and then look for this in a table of natural sines, tangents, etc., found in any of the engineer's pocket



companions, and opposite to it we will find the number of degrees in the angle $A\,E\,D$; twice this will be the number of degrees in the angle $A\,E\,B$, or the angle of the sector $A\,E\,B\,C$. To find the sine of the angle $A\,E\,D$ divide one-half the chord by the radius; hence $\frac{21.8}{24} = .90833$ is the sine, the corresponding number of degrees is 65.17, and $65.17 \times 2 = 130.34$ degrees in the angle $A\,E\,B$ of the sector. The next step will be to find the area of the sector $A\,E\,B\,C$ by the following rule of proportion: As 360 degrees is to the number of degrees in the sector so is the area of the circle to the area of the sector. The area of a circle 48 inches in diameter is 1,809.6 square inches; hence we have

$$360 : 130.34 :: 1{,}809.6 : x$$

reducing the degrees to minutes we have

$$21{,}600 : 7{,}834 :: 1{,}809.6 : x$$

from which we get 656.31 square inches for the area of the sector. From this we must subtract the area of the triangle $A\,E\,B$, which is $\frac{43.6 \times 10}{2} = 218$ square inches; hence the area of the segment will be 656.31 — 218 = 438.31 square inches. 2. Please give me the name of a book that will help me to make calculations of this kind. I am an engineer but find that I will need a license to run a plant, and I may be tripped up on some of the questions in the examination. *A.*—Any good book treating on mensuration will help you, or, better still, a good geometry which applies the principles to mensuration, Davies' Lengendre, for instance, but there are others just as good.

(222) L. E. B. and H. C. S. together ask several questions regarding bicycles, as follows: 1. What is meant by the "gear" of a safety bicycle, and how is it computed? *A.*—The gear depends upon the relation between the ratio of the sprocket wheels and the diameter of the rear or driving wheel. For instance, a machine having a 30 inch rear wheel and sprockets proportioned 2 to 1, the driving sprocket the larger, is geared to 60 inches, *i. e.*, it will travel at the same rate as if the wheel were 60 inches and had the cranks attached directly to it. 2. What is the effect of altering the size of the sprockets, keeping the same ratio? *A.*—Among the effects are that the smaller the sprockets the less they weigh and the shorter the chain is which also lessens the weight. But on the other hand the smaller sprocket wheels cause the chain to move slower for a given rate of pedaling, and impose a greater strain upon it in proportion to the decrease in its speed. This also affects in the same way the stress upon the bearings of the crank shaft and rear wheel, this stress being increased, so far as the action of the chain is concerned, in proportion as the size of the sprocket is reduced. 3. On those machines having elliptical driving sprockets is the sprocket a true ellipse? *A.*—We presume so, but are not certain. 4. The chain on this sprocket seems loose half the time. Can this be avoided either by designing a wheel so shaped as to keep the tension uniform, or in any other way? *A.*—It can be prevented in various ways, amongst others by an elliptical idler or tightener having the same number of teeth as the driver. This, however, would be objectionable, because it adds parts to the machine and increases the friction which is not admissible. The most practicable way we have heard of is by making the two sprocket wheels in the ratio of 2 to 1 and setting the smaller one on the wheel eccentrically so that the slack is taken up by it. 5. What is your opinion of the advantage of the elliptical sprocket? *A.*—Considered from a purely mechanical standpoint there is no advantage in it. That is to say, if the driving wheel were driven by steam power no more foot-pounds of energy could be derived from it by the use of an elliptical sprocket than from a round one; and driven as it is, the energy derived from the crank-shaft will always be that put into it by the legs of the rider, less the loss from friction, whether round or elliptical sprockets are used. But one sprocket may enable a rider to impart more enegy to the crank-shaft than another, and some claim this advantage for the elliptical sprocket, and theoretically the claim seems to have some foundation, but practically, and with the majority of riders, it is doubtful if any great gain results from it. This is not, however, a question of mechanics purely, but of individual adaptation and preference.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Grant's gears, Lex'n, Mass., & Phila., Pa. See p. 11.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

Ideal Drawing Stands. M. C. Hammett, Troy, N.Y.

Forming Lathes Mer. Mach. Tool Co., Meriden, Ct.

Ale Hoists, Frank Richards, Box 3686, N. Y.

Milling Machs. Kempsmith M. T Co., Mil., Wis.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 8 Spruce St., New York.

Drill Presses, with Tapping Attachments.
Gould & Eberhardt, Newark, N. J.

Davis Key Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty St, N. Y.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Pulley lathes, most efficient offered. The Lodge & Shipley Machine Tool Co., Cincinnati, O

Engine Castings, Humphreys Foundry, Bellefontaine, O.

For Cypress Tanks and Vats, address W. E. Caldwell Co., Floyd and Main Streets, Louisville, Ky.

Factory sites given away. 1 hour from New York. Address R. V. Pierce, Bound Brook, N. J.

"Pumping Machinery." New book, 450 pp, 8vo, 270 Eng. Prospectus free W. M. Barr, 3223 Powelton Avenue, Philadelphia Pa.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

"Shapers (Double Triple Quick Stroke")
Trade Mark.
Gould & Eberhardt, Newark, N. J.

For the Latest Improved Diamond Prospecting Drill address the M. C. Bullock Mfg. Co., corner Canal and Washington Sts., Chicago, Ill.

Combination, duplex and special gear cutters in stock and to order, vertical milling machines. R. M. Clough, Tolland, Conn.

Gear Cutters, Auto. Specially adapted for Motor Gears and all other style Gears.
Gould & Eberhardt, Newark, N. J.

Patent Soliciting of High Class.
D. Walter Brown, Counsel in Patent Cases,
31 Nassau Street, New York.
Send for Brief History of Patent Legislation.

De Lamater Screw Propeller Wheel, made only by The Samuel L. Moore & Sons Co., Elizabethport, N. J., who have purchased from C. H. De Lamater & Co., New York, all their patterns, books of record gauges, etc. Location and equipment well adapted for Heavy Steamship Repairs.

"Binders" for the AMERICAN MACHINIST. Two styles the "Common Sense," as heretofore sold by us and mailed to any address at $1 00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUBLISHING CO., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 postpaid. Published by John Wiley & Sons, 53 East Tenth Street, New York.

The Trial of the U. S. S. "Detroit."

Our readers will remember that in our issue of March 9 we published at considerable length an account of the trial of the U. S. S. "Bancroft," together with some comments on the advantages possessed by the method adopted in that case. Since that time the "Detroit" has been tried by a different method, and while we are not in possession of sufficient data to enable us to determine whether every care was taken to get accurate results, we shall now explain how such trials should be conducted to insure accuracy. In the preparation of this article we have derived valuable assistance from an article by Naval Constructor David W. Taylor, U. S. N., published in the *Journal of the Society of Naval Engineers* for November, 1892, entitled "Speed Trials."

The contracts for all the new naval vessels require that they shall maintain a certain

speed for four hours, under conditions prescribed or approved by the Secretary of the Navy, and a certain premium is paid for an average speed exceeding that required, while failure to maintain it is accompanied by a penalty at the same rate. In the case of the "Detroit" this amount is $25,000 for each quarter knot, so that each hundredth of a knot, or some sixty feet, is rewarded or punished to the extent of a thousand dollars.

The course for the "Detroit" was laid out in Long Island Sound in the deepest water that could be found, and was nearly forty knots long, the idea being that it would take about two hours to run over it, and it was required that two runs should be made, one each way. This was probably with the idea that the effect of the current would be about neutralized, as is the case in the short runs over a single mile, but, as we shall show presently, this would not generally be the case, and, in some cases, there might be an error of considerable magnitude.

In a trial of this kind the following data must be carefully ascertained in order to secure accuracy: The length of the course, the time taken in passing over it, and the effect of the current.

It might seem at first sight that these could all be determined without any difficulty, but an acquaintance with the actual conditions shows that in reality only the time can be found with ease and accuracy.

It is not an easy matter to lay off forty knots with perfect exactness even on shore, and when it has to be done on the water so that a sufficient depth for the trials of large fast ships is assured, it is almost impossible. Except in specially favored localities, the requisite depth of water is found only at a considerable distance from the shore (as is the case in the course for the "Detroit,") and this renders it impracticable to determine the ends of the course by ranges on shore, so that they have to be established by anchoring vessels.

It is doubtful if a vessel can be placed accurately within a hundred feet of any assigned position, and unless she is moored head and stern there is a liability to an alteration of her position after it has been established.

It is thus seen that, at the very outset, there is fair room for uncertainty as to the length of the trial course. It may be accurate, but the chances are decidedly against it.

The accurate determination of the effect of the current is even more troublesome, although by the exercise of care and the presence of numerous observers with accurate instruments, it can be obtained. In the article by Mr. Taylor it is recommended that five observers shall be stationed at intervals along a twenty-mile course, and he shows by a simple diagram how their observations can be averaged so as to secure the average effect of the current over the whole course.

It should be observed here, however, that he assumes that the current will be directly along the length of the course, which would not in general be the case. If it is not, the observations must be corrected for direction before his process of averaging can be carried out.

We have now shown how accurate results may be obtained by this method, although it involves great care and a large staff of observers. It remains to point out a few objections of a practical nature, which may cause considerable error in the speed.

Unless the wind and current are both directly along the course, it is necessary to use the helm, which increases the resistance of the vessel and reduces the speed. The effect of the wind, however, would generally be very slight, because trials are not run when there is enough wind to amount to anything. The effect of the current, however, would be considerable.

Unless the course is laid off in a place where there is little movement of shipping, there is always the possibility of a sailing vessel or a tow getting across the course and compelling the ship on trial to go off the course. The amount of this detour might be considerable, but it is difficult to make any allowance for it, and if the allowance is made, it is necessarily in the nature of an estimate, which at once destroys the accuracy of the result.

Another trouble is the possibility of fog arising. This would render it dangerous to run at high speeds, besides making it impossible to determine accurately the ends of the course. This would make the trial a failure, and compel its resumption when the fog lifted.

The large number of observers needed for securing accurate current observations renders it unlikely that as many as are really necessary will be detailed, and if observations are made only at the ends of the course the error may be serious. This is because the strength of the current as well as its direction are not the same at all points in as great a distance as forty miles.

It was remarked at the beginning that two runs in opposite directions over a long course will not in general neutralize the effect of the tide. This is shown very clearly by a consideration of one of the figures in Mr. Taylor's article, which gives the strength of the tide during its duration at each instant. From this it appears that during the first hour after the tide has turned its strength increases rapidly; during the next the increase is also rapid, but not so much so as during the first. Then it slowly attains a maximum, gradually decreases, and finally decreases rapidly during the last two hours. This figure is annexed.

It can be seen by a very simple calculation that, by suitably choosing the beginning of the runs over a forty-mile course with reference to the age of the tide, it is possible to figure out the average speed, as

Curve of Tidal Current for One Ebb Tide.
Note. The numbered spots correspond to the runs of Table IV.

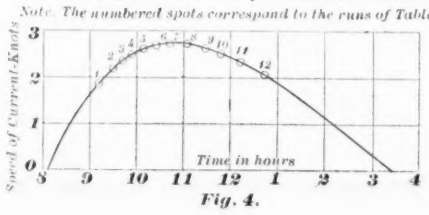


Fig. 4.

half a knot or so more or less than the true average speed. This, of course, assumes that the real velocity of the current has not been measured, but it shows very clearly why it is absolutely necessary when the speed is to be determined with great accuracy that the current should be ascertained with the greatest care.

On the whole, it may be said that, if every care is taken to insure accuracy, and no mishaps occur, this method will give the speed of a ship satisfactorily, but it involves a great deal of work and trouble, and a large staff of observers.

Compressed air cartridges are used in England in the ordinary military rifle for practice at short range.

Messages Without Wires.

The promise of electrical communication between two distant points without the agency of an intervening wire is being fulfilled with startling rapidity and almost incredible success. The wonderful capacity of the invisible electric energy for leaping across a gulf of air miles in width and unerringly delivering its message is almost daily enlarging its functions. Inductive electricity, as it is called, which thus finds the atmospheric air or the ether a sufficient conductor for its purposes, and was a few years since but little more than a theory of the laboratory and class-room, has now become a momentous fact in civilization and commerce.

It is only four years since we recorded as a remarkable triumph the feat of telegraphing to and from railway trains in motion by a parallel telegraph line. In this instance, it may be remembered, the electric message jumped across a distance of some twelve feet without any connecting wire, and this achievement on the Lehigh Valley Railway was the theme of considerable jubilation throughout the American continent. To-day English electricians at Cardiff and elsewhere are easily transmitting electric messages across a wireless distance of three miles without any sign of approaching the limits of the electric function in this direction.—*From Leisure Hours.*

While the Chinese system of smelting [tin] is similar to that of the Malays, it is more elaborate and carried out on a much larger scale. In place of the bamboo bellows, a very ingenious plan is adopted. The trunk of a tree about 18 inches in diameter and 10 feet long is carefully hollowed out and closed at either end. A long pole with a circular piece of wood at one end, fitting exactly into the bore of the tube, acts as a piston. In order to secure the tube being perfectly air-tight, the end of the piston is well padded with feathers. Valves are placed at each end to allow the air to enter, and in the center the nozzle of the bellows communicates with the furnace by means of a small air passage. On the piston being drawn out the air in the higher portion of the tube is forced down the nozzle, and, being drawn back, the air in the further part of the tube is similarly drawn into the furnace. The charcoal is soon brought to a white heat and ready for the molds.—*Consular Reports.*

MANUFACTURES.

W. P. Hunt is to build a cotton-mill at Forest City, N. C.

The Bellaire (O.) Nail Works are making improvements.

There is a plan to establish a chair factory in Foxcroft, Me.

The Duck Mill Co. at South Fitchburg, Mass., is to erect a new engine house.

The McColl (S. C.) Manufacturing Co. has recently increased its capital stock.

A new company has been chartered at Fort Plain, N. Y., to erect a shoe factory.

The Matthews Cotton mills Co., Selma, Ala., will put new machinery in its mill.

A. & P. B. Young are reconstructing their mill, recently burned at Baldwin, Me.

The Madrid (N. Y.) Woolen-mills have been incorporated, to manufacture yarn.

The capital of the Nemasket Mill, Taunton, Mass., is to be increased to $100,000.

Another cotton mill is to be started at Asheville, N. C., by C. E. Graham and others.

The Carolina Fiber Co. is erecting a paper-mill addition to its pulp plant at Hartsville, S. C.

A paper-mill is announced for Thamesville, a small village two miles from Norwich, Conn.

Phoenix Iron Works Co., of Meadville, Pa., has removed its Chicago office to 519, The Rookery.

The Falcon Co., Niles, O., will have its half-million dollar tin plant in operation in sixty days.

The C. M. Robertson managers, Montville, Conn., contemplate adding to their plant a glazing machine.

The Philadelphia Shoe Co. has been organized at Port Carbon, Penn., with capital $30,000, by G. W. Wolfe.

The Woodside Patent Calf Manufacturing Co. will soon have its new factory at Woodside, N. J., completed.

A company has been organized in Kokomo, Ind., to build and operate a large pulp and paper mill at Greentown.

The Lodge & Davis Machine Tool Co. will remove May 1 from 64 Cortlandt street to 110 Liberty street, New York

The Vager Shoe Co. has been chartered with a maximum capital stock of $25,000, by James A. Vager, Roanoke, Va.

The Empire Knitting Co. has been organized at Schenectady, N. Y., with capital $60,000, by K. C. Radcliff, A. Myers and others.

The Stevenson Manufacturing Co. has been organized, to manufacture barrels, etc., with capital stock of $50,000, at Hickory, Miss.

At Houston, Tex., Samuel Allen and Perry Allen have incorporated the Acme Lumber and Manufacturing Co., with a capital stock of $60,000.

The Esperance (N. Y.) Knitting Co. will open their new four-story mill within a few weeks. It will make wool and cotton-ribbed underwear.

The Martin Novelty Co., of Warsaw, N. Y., has been organized, to manufacture novelties. Capital, $25,000, and directors, S. B. Whitlock and others.

Virtue & Co., 72 Bible House, New York, have purchased the business of Blackie & Son in this country and will handle the books brought out by that firm.

The Chicago Steel Co. has been organized with $100,000 capital. Incorporators: Roswell W. Buckingham and A. Lehmann.

The Watertown (N. Y.) Manufacturing Co. has been organized, to manufacture underwear. Capital, $15,000 and directors, J. P. Mericle and others.

F. A. Lazenby and Samuel R. Copper have organized the Standard Electrotype Foundry and Engraving Co., with a capital stock of $10,000, at Baltimore, Md.

The Pierce Engine Co., Racine, Wis., is a new concern engaging in the manufacture of engines, having just purchased their outfit of tools from the Lodge & Davis Machine Tool Co., of Cincinnati, O.

A proposition will be made to Milwaukee, Wis., capitalists to organize a company for the manufacture of a new harvesting machine which binds grain in the field without the use of twine or wire. The inventor is Hermann A. J. Rieckert, of New York.

The new machine shop for the Eastern Forge Co., of Portland, Me., will be designed and built by the Berlin Iron Bridge Co., of East Berlin, Conn. The building will be 57 feet in width and 150 feet in length, and will be entirely of brick and iron with all modern improvements.

Col. W. N. Woodruff and others are organizing a joint stock corporation, to be located in Hartford, Conn., and known as the Green Electric Lamp Company. The company expects to organize with a capital of $100,000, and its works will add another to the rapidly increasing industries of Hartford.

The Fryeburg Manufacturing Company has been organized at Fryeburg, Me., with $25,000 capital stock, for the purpose of manufacturing and dealing in all kinds of lumber, furniture, chairs, etc. The officers are: President, A. R. Jenness, of Fryeburg; treasurer, Edward E. Hastings, of Fryeburg.

The National Pipe Bending Company, of New Haven, Conn., manufacturers of the national feed-water heater, have recently sold three large heaters for new mills in New Bedford, Mass., the new Wamsutta mill having a heater of 1,600 horse-power, the new Pierce mill a 1,400 horse-power, and the new Columbia mill 800 horse-power.

The Hopedale Electric Company, of Hopedale, Mass., is erecting a building 180x60 feet for car works. Plans are now drawn for six shops with power house 200x60 feet. The cars running between Hopedale and Milford using the storage battery have been running for the past nineteen months without a single delay during the whole period.

About 600 acres of land have been purchased about 5½ miles above Elizabeth, Pa., by a syndicate of glass manufacturers with the intention of erecting a town thereon. They will erect a factory of much greater capacity than those owned now. They will incorporate under the title of the Pittsburgh Glass Co., with a capital of $1,000,000. S. McKee & Co. will also join the combine and remove their window glass factories to the new town. Work will commence at once.

J. H. Lakin, of Westfield, Mass., together with Boston, Mass., and Portland, Me., capitalists, has formed a company to establish a casket manufactory at Livermore Falls, Me. A plant with 1,000 H. P. has been bought, and work will be begun at once. The goods are made under a new process of wood pulp, which is molded into the desired shape under heavy pressure. They are afterward chemically treated and are made water and air-tight. The new plant is to turn out from 100 to 300 caskets a day.

The firm of Dietz, Gang & Co., of Cincinnati, O., manufacturers of patent radial drills and improved engine lathes has been dissolved by mutual consent, William E. Gang retires, having sold his entire interest and good-will with all rights to manufacture the same tools as heretofore. The new firm of Dietz, Schumacher & Co. will collect all accounts and assume and pay all liabilities of the late firm. The new firm will double its capacity in the next 90 days and will bring into the market a new B. G. and P. F. radial drill with the back gear direct on the spindle, thus insuring an easy reach and great power.

The Connersville Blower Co., of Connersville, Ind., has just been organized for the purpose of manufacturing rotary positive pressure blowers, gas exhausters, pumps, motors, etc., the internal working parts of which will consist of two impellers planed accurately on cycloidal lines. This end will be reached by means of a planer invented by Mr. John T. Wilkin, the engineer of the company, and which will be described in one of the coming issues of the AMERICAN MACHINIST. The company's capital will be $75,000, $65,000 of which has been subscribed. Shops are already under way, and the company intends to contract for a power plant, milling machines, lathes, planers, cylinder boring machines, shafting, belting, etc., in fact everything needed in a complete equipment.

Machinists' Supplies and Iron.

NEW YORK, April 29, 1893.

Iron—American Pig—We quote Standard Northern brands, No. 1 Foundry, $14.50 to $15.25; No. 2, $13.50 to $14.25; Gray Forge, $12.75 to $13.50. Southern brands of good quality are obtainable at $14.25 to $14.50 for No. 1 Foundry; $13 to $14 for No. 2 and $12 to $13 for Gray Forge.

Antimony—The market is dull. We quote L. X., 10¼c. to 10½c.; Cookson's, 10½c. to 10¾c.; Hallett's, 10.10c. to 10½c., and U. S. French Star, 10⅜c.

Copper—The market has a downward tendency with 11½c asked for Lake Copper and with a probability that 11c. would buy. Casting Copper is held at 10¾c. to 10⅜c.

Lead—The market is unsettled and orders are postponed; second hands are asking 4.05c.

Lard Oil—Prime City is quoted at 84c. to 85c.

Spelter—The market is dull at 4.45c. asked, but the demand is very light.

Tin—The market is easier. Sales were 25 tons spot at 20.55c.; 130 tons April at 20.57½c to 20 60c.; 50 tons May at 20.60c., and 10 tons June at 20.80c.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Wanted—Salesmen on commission, to push a special line of mach'y. "Kirk," care of AM MACH.

Wanted—Foremanship; engines, pumps or general jobbing. Indicator, AMERICAN MACHINIST.

Wanted—Place to work at pattern making under instructions. Address BOX 101, AM. MACHINIST.

Foreman in iron foundry, all kinds of light or heavy gray iron castings, green or dry sand; best of references. Box 100, AMERICAN MACHINIST.

Wanted—An experienced and competent man as sup't in forging department of a carriage hardware manufactory. Manufacturer, Box 58, AM. MACH.

Wanted—Eight or ten first-class machinists, bench hands, etc.; steady employment; state wages and experience. Address Box 102, AM. MACHINIST.

Wanted—Six planer, ten lathe and ten vise hands; must be thorough practical machinists. S. K. White, 75 North Clinton street, Chicago, Ill.

Successful superintendent of foundry and machine works wants to change location; can bring superior automatic engine and other paying machines and work. Expert, AMERICAN MACHINIST.

Wanted—A young man, graduate of College or Manual Training School, who has had a little shop and drafting office experience. Address Box 99, AMERICAN MACHINIST.

Wanted—By competent man, position as foreman of machine shop engaged in jobbing, repairing, or paper machine work. Address Box 304, Groton, Mass.

Mechanical engineer with large experience in drawing-room, also well able to superintend construction of work, desires engagem't as draftsman & take gen. supervis'n of work. Box 106, AM. MACH.

Foreman Wanted—Who can rub men the right way to increase production and do good work. One familiar with high grade engines desired. H. G., P. O. Box 1001, N. Y.

Foreman pattern maker, age 32, 10 years' experience on machine tool, gearing and special machinery, and some exp. in drafting, desires situation; best of references. Box 107, AM. MACHINIST.

Draftsman Wanted—To grow into responsible place in drafting room. Mod price to start. Worcester tech. graduate preferred. Address, giving exp., and wages expected, Box 93, AM. MACHINIST.

Wanted—Two good molders for dry and green sand work machinery, castings, etc. To save time in writing we wish to know what exp. you have had; age and wages expected. Box 200, AM. MACH.

Wanted—Position as foreman in iron foundry; experience twenty years; age 40; holding similar position in a first class jobbing shop at present; references furnished. Address Box 104, AM. MACH

An engineer is open to engagement to take charge of exhibits at World's Fair, of machine tools, steam engines, or other machinery; references A1. Address Box 103, AMERICAN MACHINIST.

An active man, 32, experienced in the accounts of a machine shop and foundry is open for engagement; undoubted references. Address Accountant, Box 41, 323 Canal st., N. Y.

Wanted—A situation by one with over 30 years' experience in foundry and machine shop, more than half the time in charge of both departments, best of references. Address P. O. Box 358, Foxboro, Mass.

Wanted—Tool makers accustomed to jig and fixture work; permanent employment and good wages to men familiar with this line of work. Address Wardwell Sewing Machine Company, Woonsocket, R. I.

Position wanted with progressive concern by an educated mechanic who has large exp. designing and building machine tools, engines and gen'l machinery; successful manager of shop & men; pos'n as designer or sup't preferred. Box 89, AM. MACH.

Wanted—Position as superintendent or foreman by a young man, at present erecting large engines for a well-known firm Extensive exp. First-class machinist, engineer and electrician. Cornell graduate. Desires to locate permanently with some reliable firm. Pusher, AMERICAN MACHINIST.

Wanted—First-class Corliss engine general salesman, of character and repute competent technically and practically to estimate on any power plant, and willing to live and travel anywhere west. Address, giving experience, reference and salary expected, T. E. G., AMERICAN MACHINIST.

Draftsman wanted; machinists wanted—We want a draftsman to make working drawings on cotton machinery; one that is competent to make patent office and working drawings; one exp'd in a cotton mach. building estab't pref'd; also 3 good men for setting up our machines in our shop & on the road. Foster Machine Co., Westfield, Mass.

(*Continued on page* 12.)

Bradley Hammers.

If you plate, draw, square, taper, swage, collar, spindle, or do any manner of die forging in iron or steel, a BRADLEY HAMMER will soon pay for itself, by what it will save over any other similar tool. Send for circulars.

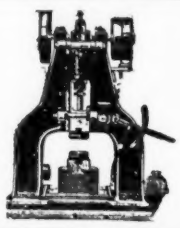
BRADLEY & COMPANY, SYRACUSE, N. Y.

HACKNEY HAMMERS

Meet all requirements more fully and satisfactorily than any other of its competitors.

INVESTIGATION IS NOT COSTLY.
INVESTIGATION IS CONVINCING.

WRITE FOR CATALOGUE TO
THE HACKNEY HAMMER CO.
20 Johnson St., CLEVELAND, O.



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Ready Made Cast Gears.
Ready Made Brass Gears.
Gears Made to Order.
Gear Cutting.
Gear Book, 15 cents.
Treatise on Gears, $1.00.
Gear Cutting Machines.
GEORGE B. GRANT,
Lexington, Mass.,
and 125 South 11th St.,
Philadelphia, Pa.

STEAM BOILERS

Their Construction, Strength and Economical Working.

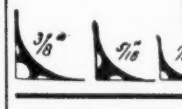
BY ROBERT WILSON AND J. J. FLATHER.

"THE STANDARD FOR PRACTICAL MEN."

108 Illustrations, Tables, etc., 12mo. Cloth, $2 50.

JOHN WILEY & SONS, NEW YORK.

HOW TO COMPUTE THE HORSE POWER OF A STEAM ENGINE. Use the Average Steam Pressure and Horse Power Indicator, which give it at once for any Cut-off. Price, $2.00. Published by KEUFFEL & ESSER CO., New York, (Branch, Chicago). Drawing Materials and Surveying Instruments.



Flexible Metallic Fillet

For Pattern Makers. 8 Sizes.

H. WHITE, 44 N. 4th St. Phila, Pa.

ELECTRICON.

The Best Anti-Friction Metal in the World.

FOR ALL

MACHINE, RAILWAY AND MARINE BEARINGS.

HIGH QUALITY. LOW PRICE. SEND FOR SAMPLE.

UNION ELECTRIC COMPANY,

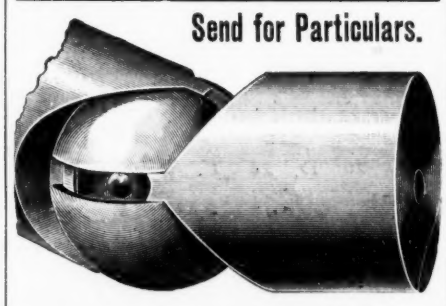
Manufacturers and Sole Agents, 45 BROADWAY, N. Y.

WEALTH

is what you want? You must have business to obtain it. Your work must be of the best to get business. You can't get good work without good machinery. Machinery won't work well unless the gearing is accurate. You get accuracy in our MACHINE MOLDED gear wheels. Wear — because they are made from our SPECIAL PROCESS charcoal iron. Write us.

UNION FOUNDRY & MACHINE CO.,
PITTSBURGH, PA.

Send for Particulars.



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HARTFORD, CONN.

MACHINERY

For Reducing and Pointing Wire.

ESPECIALLY ADAPTED TO POINTING WIRE RODS AND WIRE FOR DRAWING.

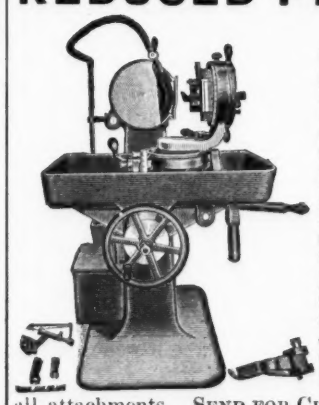
For Machines or Information address the Manufacturer,

S. W. GOODYEAR, Waterbury,

SEND FOR CATALOGUE.
WORCESTER MACHINE SCREW CO.

Manufacturers of Set, Cap & Machine Screws, Studs, etc.

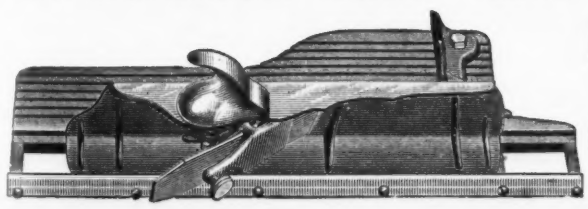
REDUCED PRICE.



On account of the economy resulting from the manufacture of our Universal Tool Grinding Machine in lots of 50, we are enabled to reduce the price materially while adding to the efficiency of the machine by supplying all attachments. SEND FOR CIRCULAR.

GISHOLT MACHINE CO., Madison, Wis.

PATTERN MAKERS' SHOOT PLANE & JACK BOARD.



A. J. WILKINSON & CO.

180 to 188 WASHINGTON ST.,

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SOMETHING NEW!

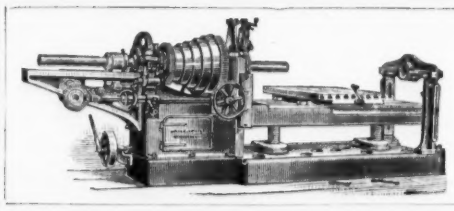
NICHOLSON'S COMPRESSION SHAFT COUPLINGS

W. H. NICHOLSON & CO., Wilkes-Barre, Pa.

The Manufactory of Precise Measuring Instruments of Aug. Kirsch & Co.,

At DAMM ASCHAFFENBURG, (Bavaria),

wants for the sale of their manufactures for the construction of machines a connection with wholesale houses and dealers in tools. Best, most exact execution of orders at reasonable price.



BETTS MACHINE CO.,
WILMINGTON, DEL.

MACHINE TOOL BUILDERS.

IMPROVED PATTERNS! LATE DESIGNS!

Chicago Office: 14 South Canal St.

Depth Gauge.

Price, 40 Cents, *Postpaid.*

This instrument we have found very useful in our shop, and we offer it for sale. It is as well made as any similar tool in the market. Nickel plated. No trade discount.

ASBESTOS CEMENT FELTING,

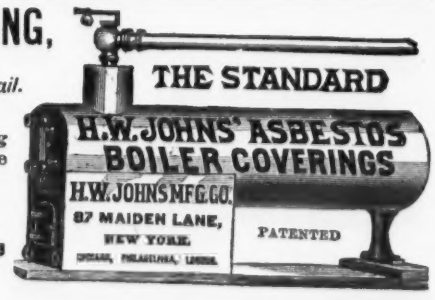
FOR LAGGING LOCOMOTIVE BOILERS.

Samples and Descriptive Price List Free by Mail.

We are prepared to take Contracts for applying Steam Pipe and Boiler Coverings in any part of the United States.

H. W. JOHNS MANUFACTURING CO.,

87 Maiden Lane, NEW YORK.



Wanted—A position as foreman by mechanic of over 25 years' experience. Is an expert on getting up special milling fixtures, cutters and drill jigs, etc., (on small and large work) of the newest methods; turning out accurate, cheap and quick work; is a thoroughly practical tool maker and machinist, and has run shops with from 30 to 200 men. Highest references furnished. Address Box 105, AMERICAN MACHINIST.

✣ MISCELLANEOUS WANTS ✣

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S. M York, Clev'd, O.

Auto. Steam Flue Cleaners. Kelley Co., Erie, Pa.

Working drawings, etc. J. D. Riggs, Toledo, O.

For Sale—Second-hand drill presses, engine lathes and planers. Dietz, Gang & Co., Cincinnati, O.

Light and fine machinery to order: Foot Lathe Catalogue for stamp. E. O. Chase, Newark, N. J.

Best Bolt Header in the world for $50. Address C. H. Baush & Sons, Holyoke, Mass.

Wanted—Machinery and specialties to build. P. G. Fleming's Machine Works, Elizabeth, N. J.

Screw cutting lathe and chucks, 18" swing, perfect, complete, good maker, $95. 229, AM. MACH.

For Sale—8 different vols. AM. MACH. 1 vol. Scientific Am.: clean, good, $12. J. P. R., AM. MACH.

For Sale—Half interest in a well-established machine shop and foundry in a city in Western New York. Address Works, AMERICAN MACHINIST.

Wanted to purchase a small machine shop nicely equipped for building light machinery, doing model work, etc. Address, giving full particulars, W. D, AMERICAN MACHINIST.

Wanted—18 to 25 inch shaper, 20 to 22-inch lathe, 10 foot bed, 16 to 18-inch tool lathe, 8-foot bed. Complete specifications must accompany each proposal; also state time of delivery. Phoenix Iron Works Co., Meadville, Pa.

Two machinists and tool makers would like any kind of machinery to build by contract, work to be done at employer's manufactory. Good practical workmen, understand their business thoroughly. Best of reference as to character and ability. Address Good Workers, AM. MACHINIST.

FOR SALE.

The entire outfit of two well equipped Machine Shops, which we have just purchased. The lot comprises:

DRILL PRESSES,
ENGINE AND HAND LATHES,
PLANERS, SHAPERS.
PLAIN AND UNIVERSAL MILLERS,
CUTTER, SURFACE AND
UNIVERSAL GRINDING MACHINES,
SCREW MACHINES,
TAPPING AND CENTERING
MACHINES,
POWER PRESSES,
GEAR CUTTERS,
SQUARING SHEARS,
GRINDSTONES,
FORGES AND ANVILS.

All can be seen in our warerooms. Write for photographs, description and prices of tools wanted.

THE GARVIN MACHINE CO.,
Laight and Canal Streets. New York.

SECOND-HAND AND NEW MACHINERY

Planers.	54 in. x 24½ ft. 2 Heads.	Planers.	26 in. x 7 ft.
"	42 in. x 16 ft.	"	25 in. x 5 ft.
"	36 in. x 12 ft.	"	24 in. x 5 & 6 ft.
"	31 in. x 8 ft.	"	22 in. x 5 ft.
"	30 in. x 7 ft.	"	20 in. x 4 ft.

80 in. x 18 ft. Engine Lathe Geared Face Plate.
60 in. x 45 ft. Double Engine Lathe.
52 in. x 35 ft. Engine Lathe Horizontal Boring Machine, one end.
30 in. x 28 ft. Pond Machine Tool Co. Shafting Lathe.
36 in. x 16 ft Engine Lathe.
33 in. x 27 ft. " "
32 in. x 12, 14, 16, 18 ft. Bed. New Engine Lathe.
28 in. x 22 ft. Engine Lathe, cheap.

25 in. x 12, 16, 20 and 24 ft. Bed.	New	do	do
21 in. x 10, 12 ft.	Bed.	do	do	do
20 in. x 5, 6 & 8 ft.	do	2d Hand	do	do
18 in. x 6, 7 & 8 ft.	do	New &	do	do
17 in. x 8 ft.	do	do	do	do
16 in. x 6 & 8 ft.	do	do	do	do
15 in. x 6 & 8 ft.	do	do	do	do
14 in. x 6 ft.	do	do	do	do

Car Axle Lathe, Bement. | Driving Wheel Lathe 88 in.
15, 16, 18, 25 in. Crank Shapers. | Wheel Quartering Mach.,
20, 24, 26 & 30 in. Geared Shapers. Double.
20, 22 24, 28, 30 & 36 in Drills. | No. 0 Turret Lathe,
Bolt Cutters. | Am. Tool and Mach. Co.,
8 and 13 in. Stroke Slotters. | 24 in. Swing, 8 ft. Bed.
Lot of Lincoln Pattern Millers and No. 1 P. & W. Millers.
2 Spindle Drills. Garvin. No. 75 Bliss Press Geared.
Gear Molding Machine.
1100 and 3000 lb. Bement Steam Hammer.
100 lb. Steam Hammer. | SEND FOR MARCH LIST.
40 H. P. Vert. Engine. N. Y. S. S. P. Co.
11 in. x 18 in. Hor. Engine. A1 Order.
16 in. x 42 in. Corliss and 16 in. x 48 in. Brown Eng.
300 H. P. Westinghouse Comp'd Engine.

GEO. PLACE MACHINE CO.,
120 BROADWAY, NEW YORK.

ENGINEERS

and gentlemen having business with Steam Users, wanted as agents to represent a prominent manufacturer. Write for circular and terms. Mention this paper.
Address **P. O. Box 137,** Philadelphia, Pa.

Experimental Work of every Description,

Mechanical and Electrical. Contractors for the manufacture of specialties, or can furnish complete plants for their manufacture. Make Dies, Special Tools, Gauges, Drawings, Patterns, Models. Inventions perfected. Estimates furnished. Correspondence solicited.

Send for Circular of our SENSITIVE KNEE DRILL.
BRADY M'F'G. CO. 83 Washington St., BROOKLYN, N. Y.

REMOVAL

MAY 1st to

14 DEY STREET.

We will close out at low prices previous to time of our removal the following

New and Second-Hand Machine Tools.

Engine Lathe, 24 in. x 12 ft. Cpd. Rest and Cross Feed.
" " 22 in. x 10 12, 14, ft. " new heavy pattern."
" " 21 in x 10 ft., Cpd. Rest—Hol. Spin. 1 9-16 in.
" " 20 in. x 8, 10 ft., Cpd. Rest and Cross Feed.
" " 18 in. x 8 ft., complete—Hol. Spin., Cross Feed.
" " 17 in. x 9 ft., " (Lathe & Morse). " $100
" " 16 in. x 7 ft., " (old style). " $50
" " 16 in. x 8 ft., " with Chuck, "modern." A1
" " 13 in. x 6 ft., Cpd. and Cross Feed, " new style."
Planer, 24 in. x 5 ft., complete, full Auto. Feeds.
" 24 in. x 6 ft., " " new heavy pattern.
" 24 in. x 6 ft., " Lathe & Morse. Good
" 28 in. x 6 ft., " Good order
" 30 in. x 8 ft., " latest pat., ex. heavy. Good as new
Shaper, 6 in. stroke, 22 in. feed, complete. Good. Price, $80
" 9 in. " "Crank Motion" complete. Good order
" 13 in. " " extra heavy. "
" 13 in. " trav. head with 60 in. feed, complete, with two tables and circular feed, ex. heavy. Good order
" 20 in. stroke, crank motion, extra heavy. A1 order
" 22 and 26 in. Triple Geared, "new style."
Drill, 13 in wheel feed, (Putnam). Price, $35
" 20 in. " " new. " $55
" 32 in. back gears and auto. feed, complete.
Radial Drills, 3 ft. and 6 ft. arms "new heavy pattern."
Upright Boring and Turning Mill, 38 in., complete.
Slotting Machine, 8 in. stroke, modern style, complete. Good
Key-seating Machine, for pulleys and wheels, all sizes, new pattern
Milling Machine, "Lincoln pattern" Good order
Brown & Sharpe Turret Chucking Machine. A1 order
National 1⅝ in. Double Bolt Cutter, with dies.
Bolt Cutter, for accurate thread cutting, 1½ in., with dies and taps.
Bliss style Punch Press. New
Long & Allstatter Punch and Shear Boiler Bending Rolls, 8 feet, improved style.

J. J. McCABE,
SUCCESSOR TO
E. P. BULLARD'S
N. Y. Mach'y Warerooms,
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JESSOP'S STEEL

FOR TOOLS, DRILLS, DIES, &C.

ALL KINDS IN STOCK.
Manufactory, SHEFFIELD, ENG.
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WM. JESSOP & SONS, LD.
Established a century ago.

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REAMERS
DRILLS
SCREWS
BELTING
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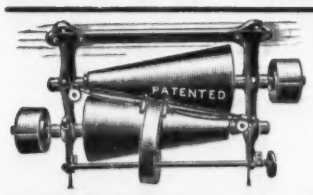
LIST "J" ON APPLICATION.
FRASSE & CO.,
90-94 PARK ROW, NEW YORK CITY.



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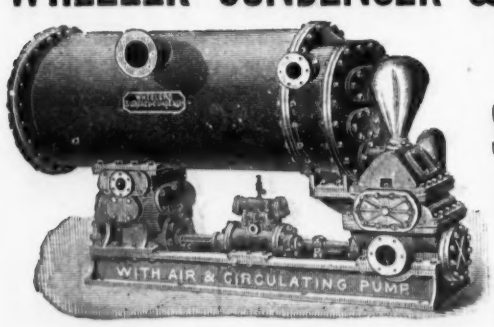

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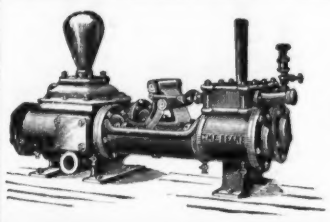

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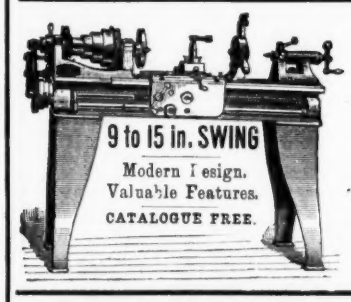

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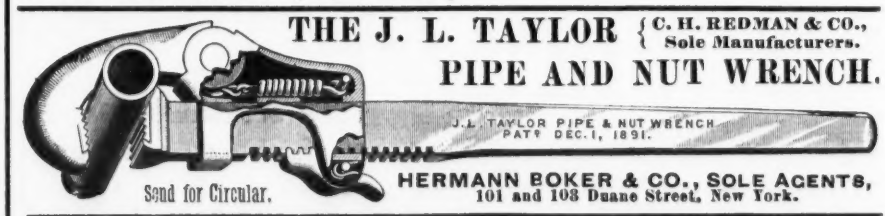

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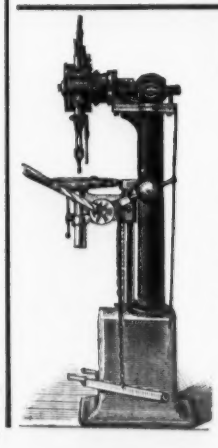

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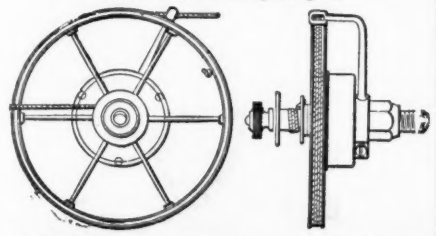

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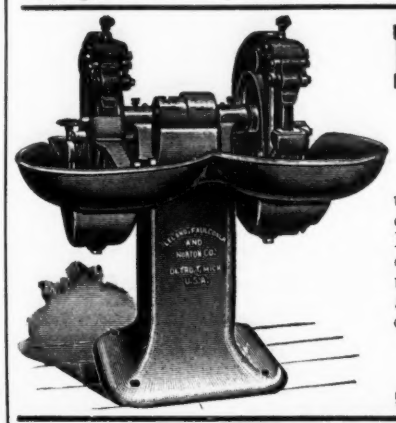

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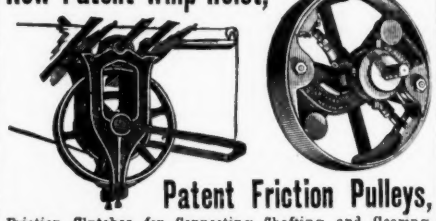

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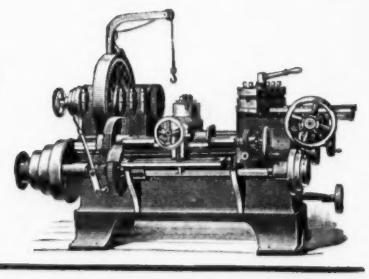

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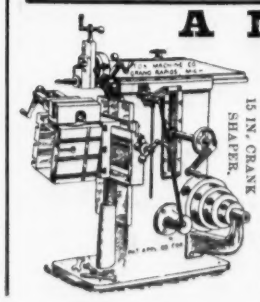

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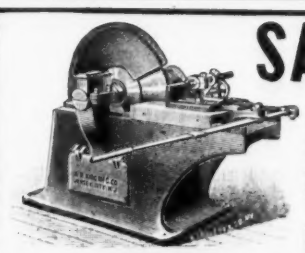

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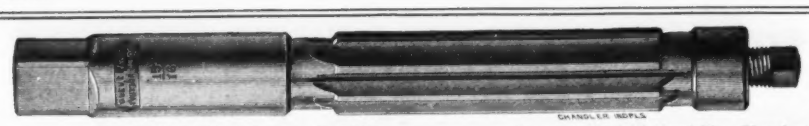

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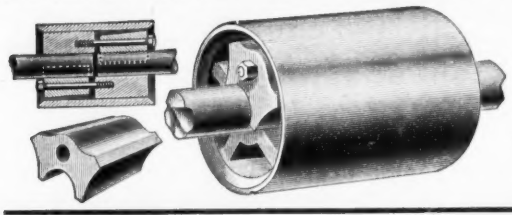

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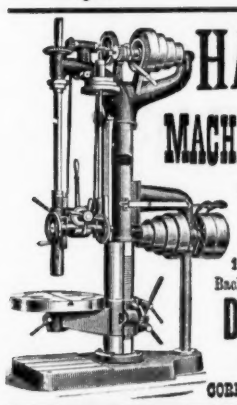

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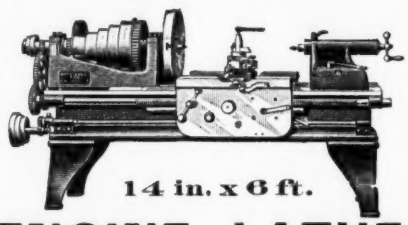

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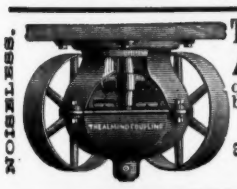

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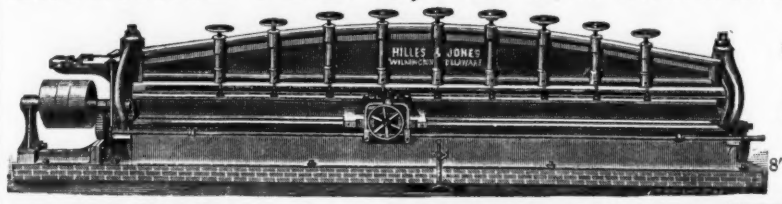

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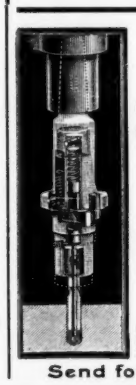

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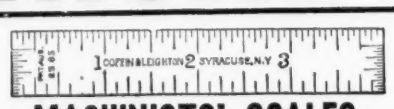

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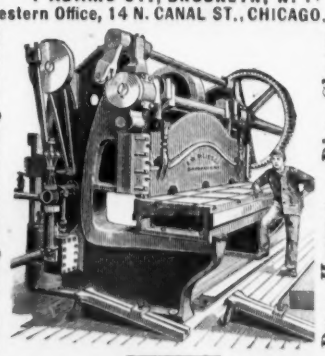

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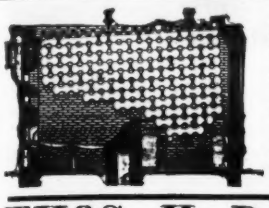

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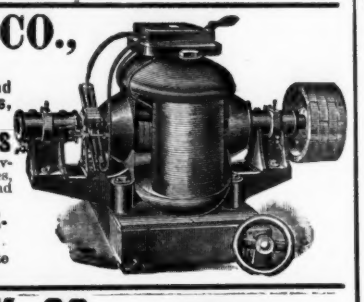

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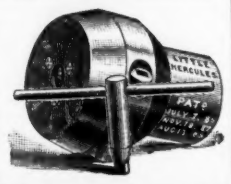

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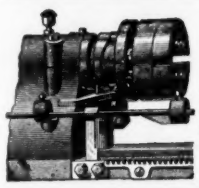

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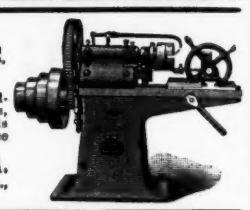

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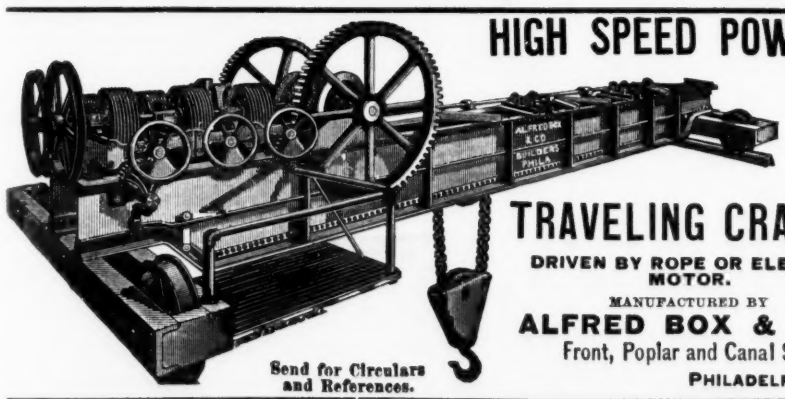

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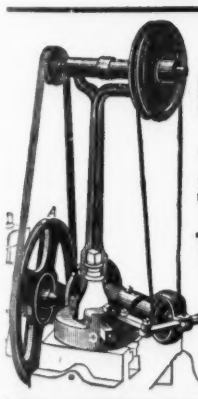

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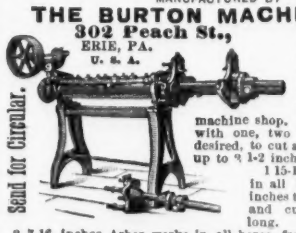

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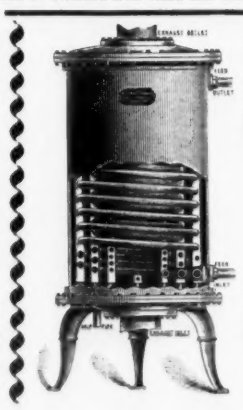

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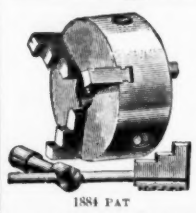
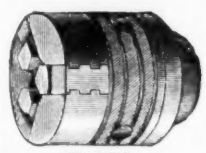

1884 PAT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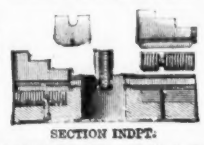
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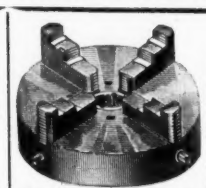

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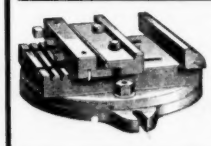

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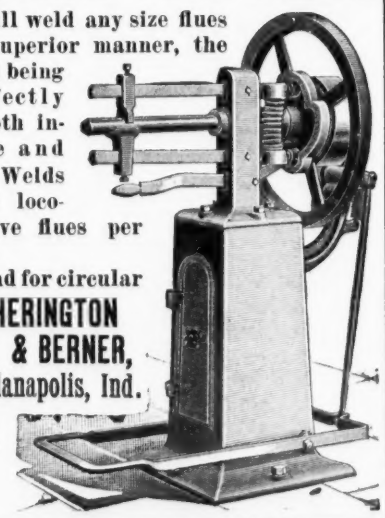

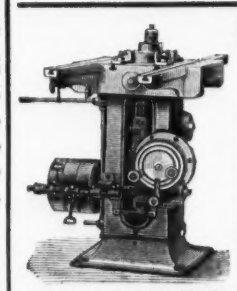

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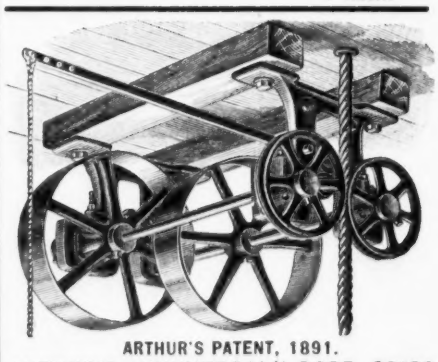

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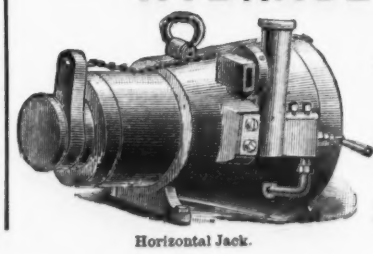
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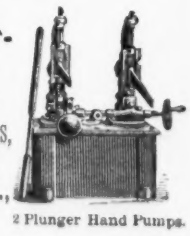
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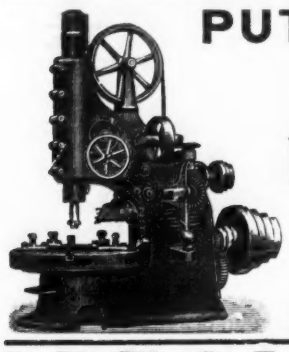

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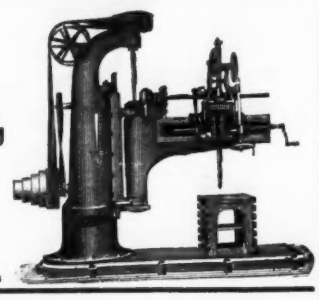

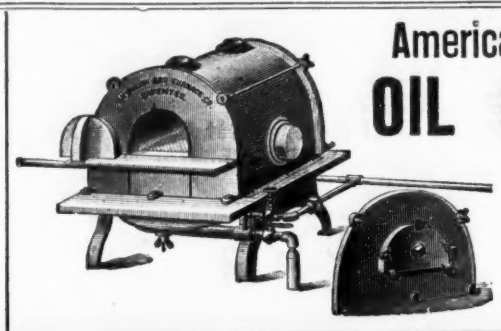

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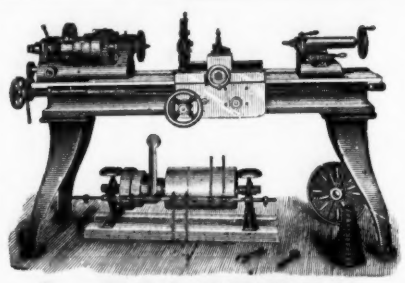

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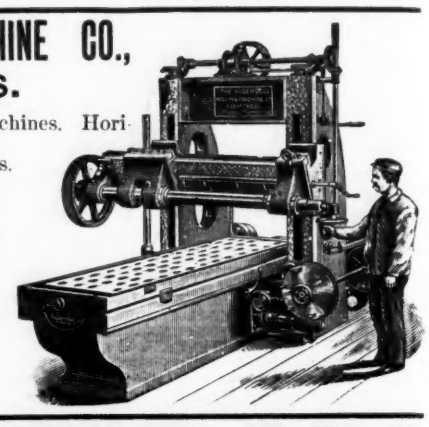

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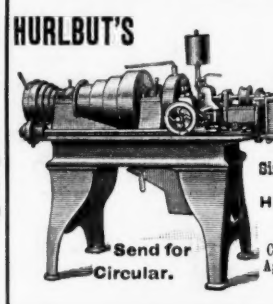

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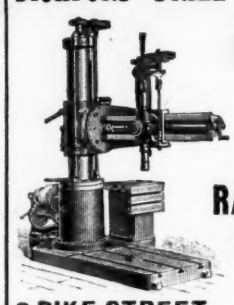

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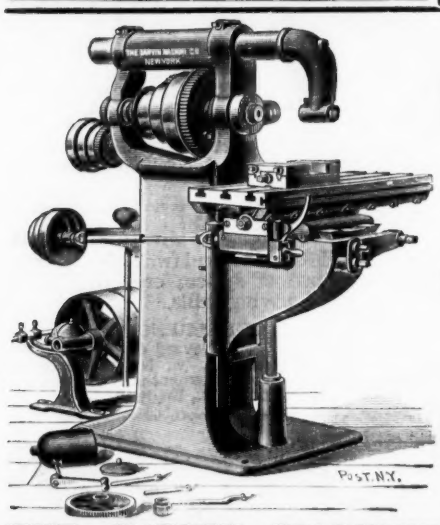

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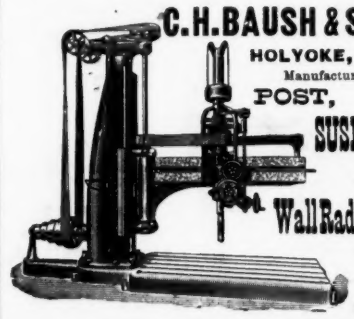

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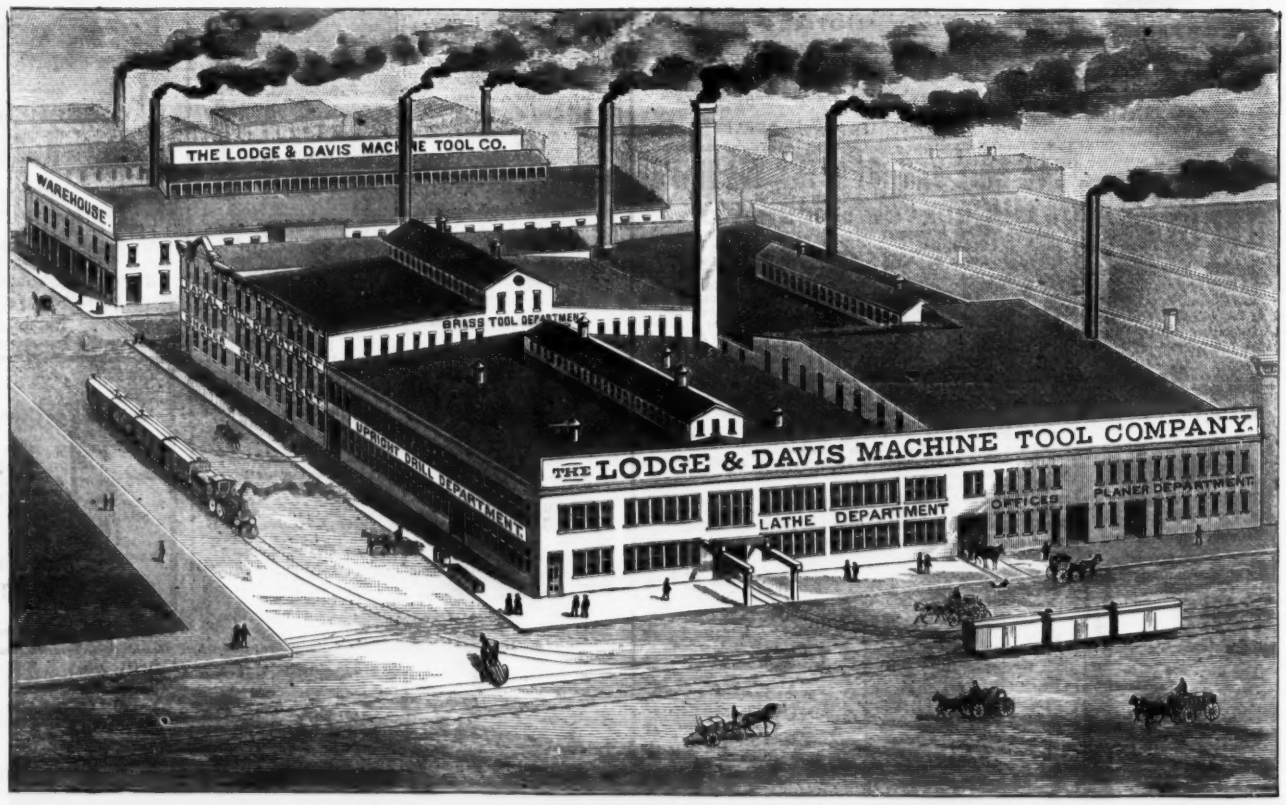

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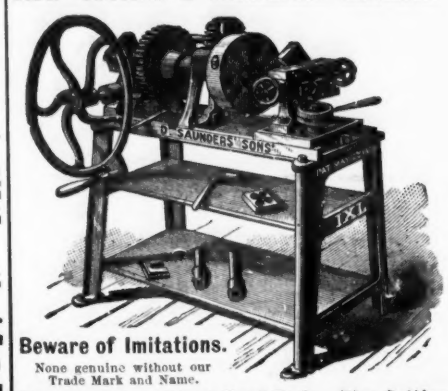

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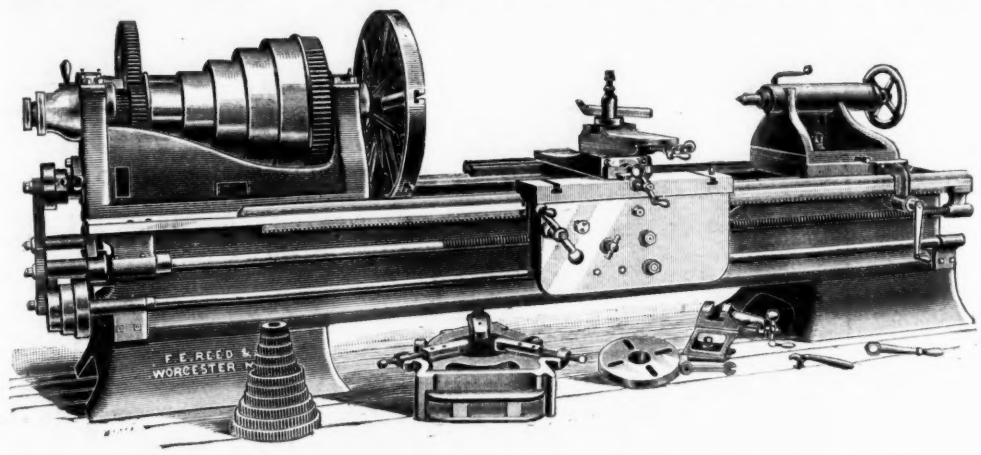

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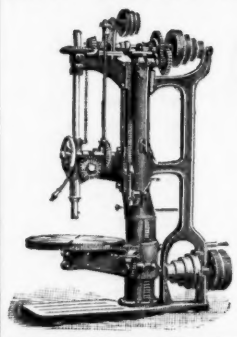

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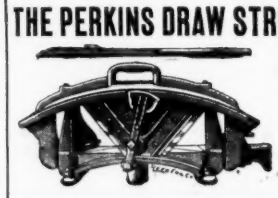

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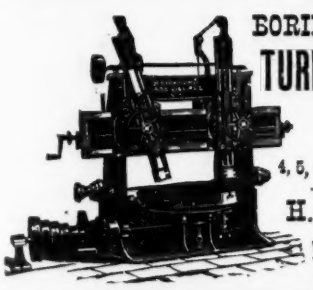

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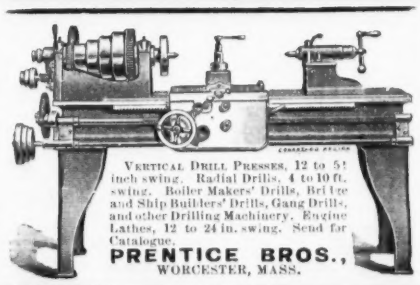

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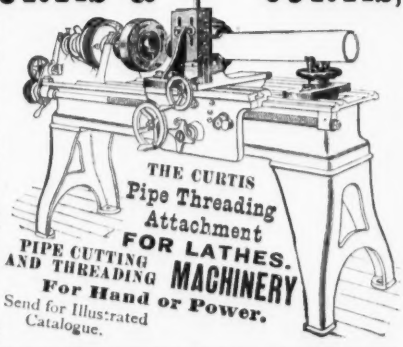

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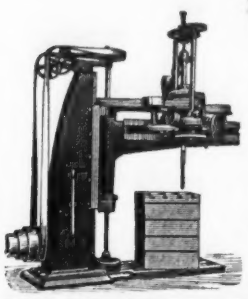

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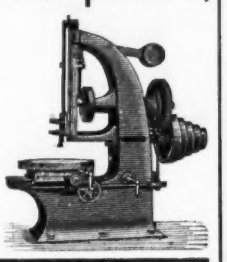

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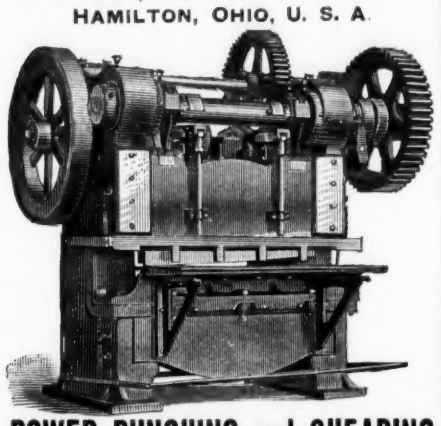

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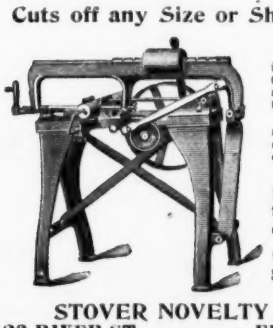

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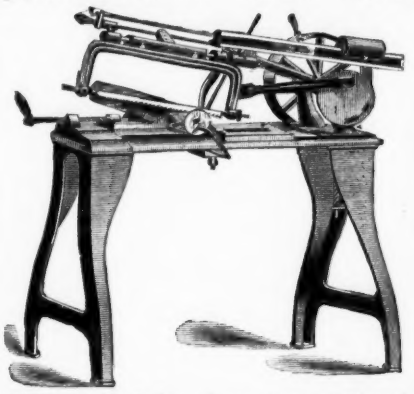

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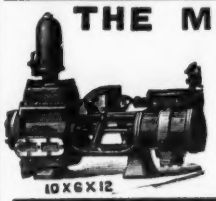
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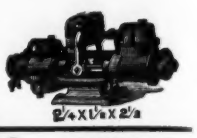
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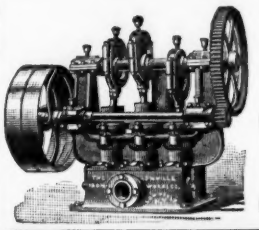

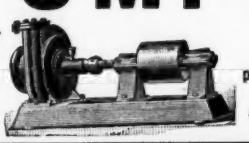

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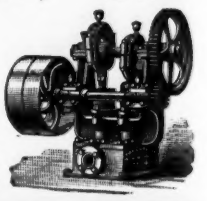

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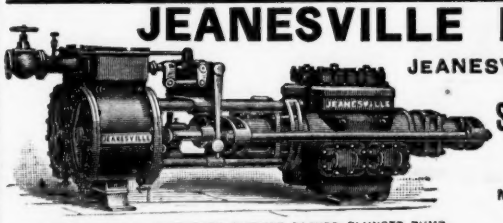
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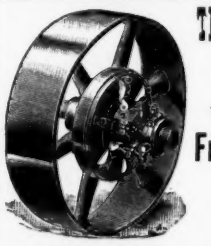

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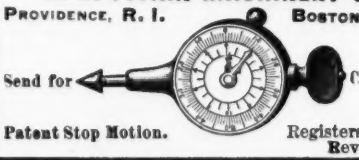

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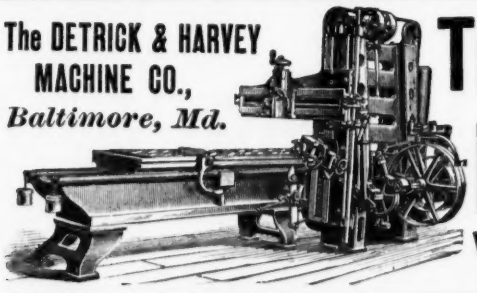

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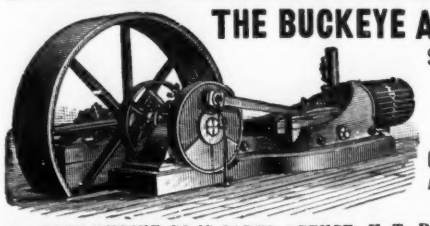

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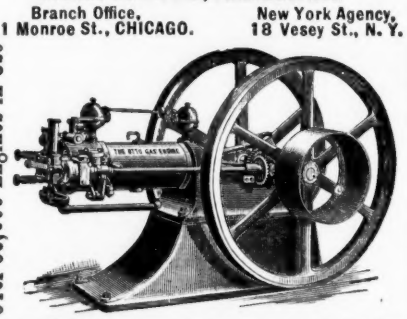

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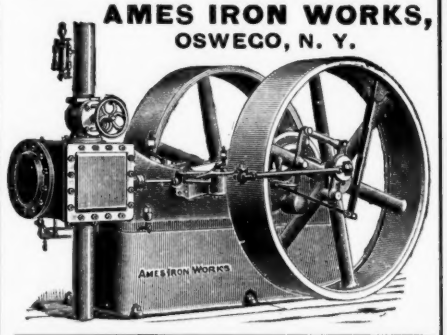

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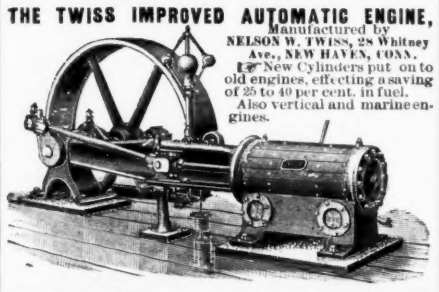

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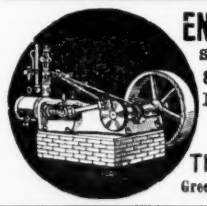

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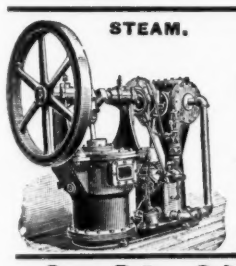

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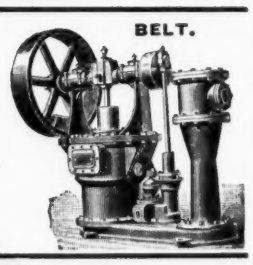

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Compound Condensing Corliss Engine on Independent Condenser.
HANDSOME CATALOGUE FREE.
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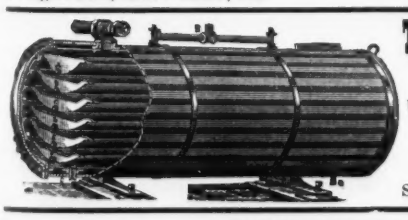

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Guaranteed to Prevent Scale in Boilers.
Using any kind of water. Hard Sheet Steel Troughs.
Easily Cleaned.
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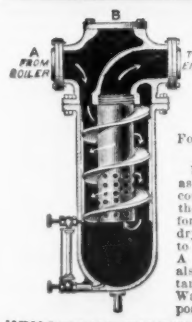

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Simpson's Centrifugal Steam Separator.

For Supplying Clean and Dry Steam to Engines, Dry Houses, etc.

Place Separator as close to engine as possible, the steam taking a spiral course between the threads causes the water to be thrown by centrifugal force against the outer walls, while the dry steam goes through the small holes to center of pipe. Steam can enter at A or B, as convenience may require; also used in conveying steam long distances, for Steam Hammers, Dry Houses, Water Gas Generators, and for all purposes where Dry Steam is necessary.

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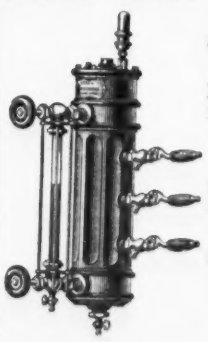

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Burn less coal, and have the satisfaction of feeling safe, by using
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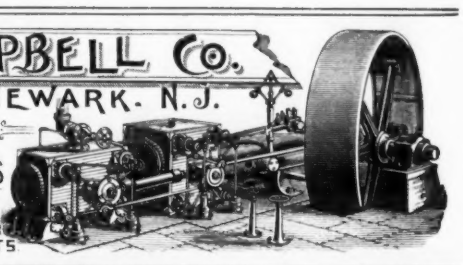

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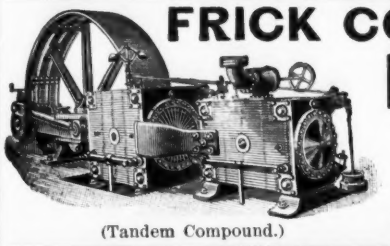

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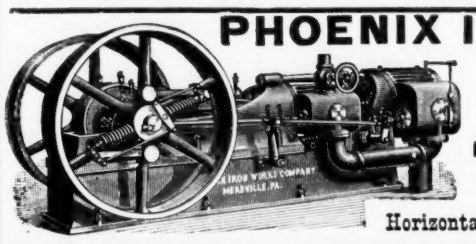

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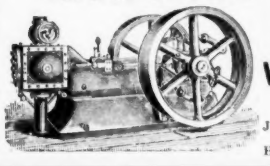

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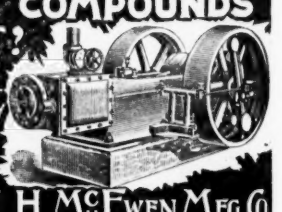
The engine shall not run one revolution slower when fully loaded than when running empty, and a reduction of boiler pressure from the greatest to that necessary to do the work, will not reduce the speed of engine one revolution. Any engine failing to meet this guarantee becomes the property of the purchaser upon payment of one dollar. Send for Catalogue.



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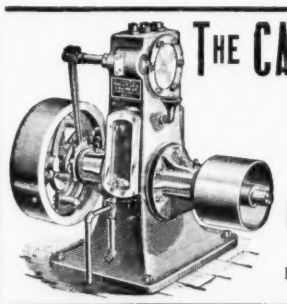

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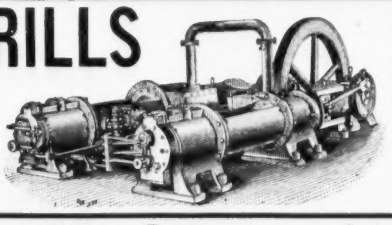

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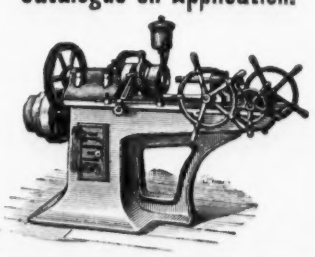

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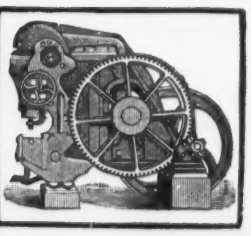

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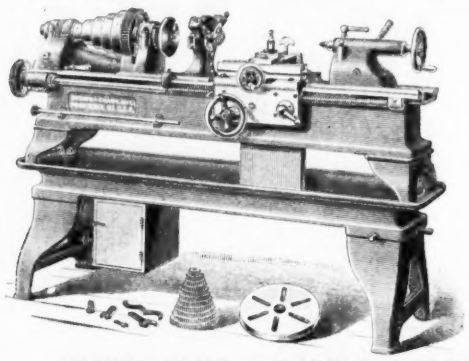

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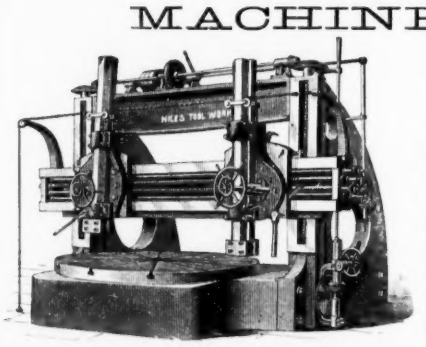

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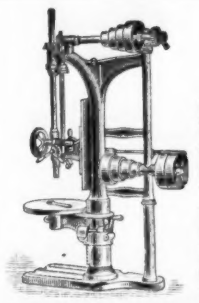

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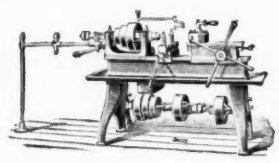

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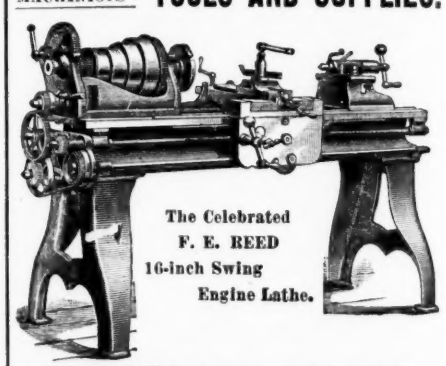

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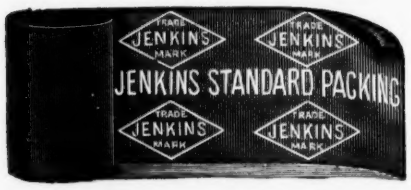

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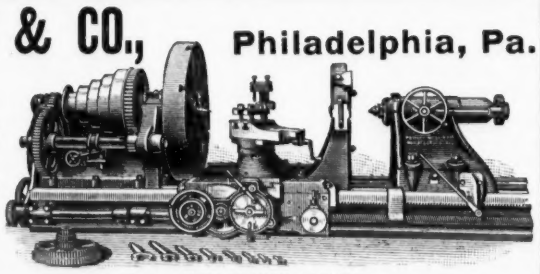

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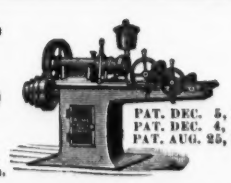

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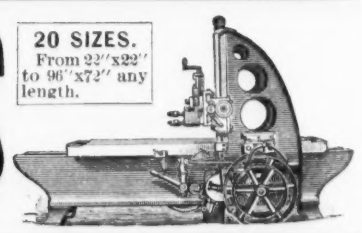

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